Head & Neck Imaging

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Chapter 2: PNS
Chapter 3: Parapharyngeal spaces
Chapter 4: Petrous bone
Chapter 5: Skull Base

Sources:
Handbook of head and neck imaging
Diagnostic imaging of head & neck
Primer of diagnostic imaging
Radiopedia
Radiology assistant
Radiographic journal
MRI Master

ORBIT

I. Globe

II. Optic nerve

III. EOM

IV. Lacrimal gland

V. Retro-orbital fat

VI. Orbital bony walls

Orbit Technique

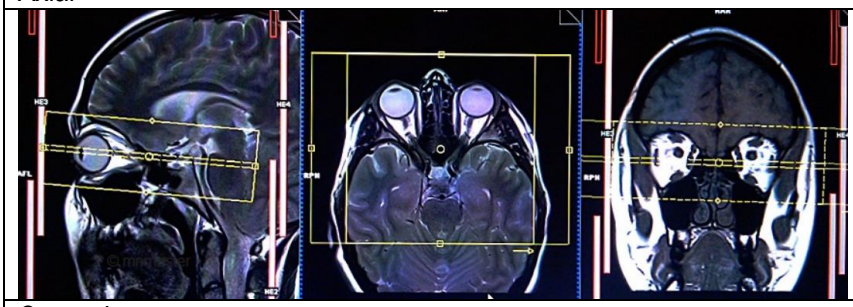
CT Protocol

Axial and coronal soft tissue window (350w/40L)
Axial and coronal bone window (4000W/500L)

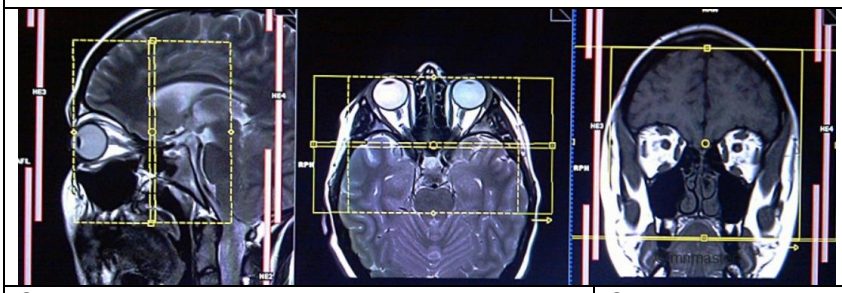
MRI Protocol

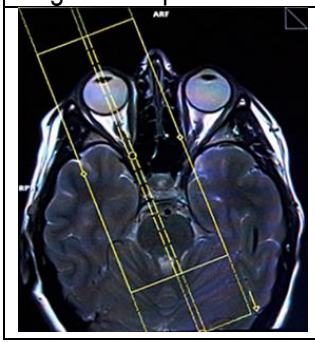
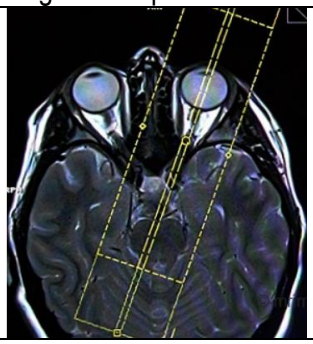
Axial T2 of the brain
Axial T1
Axial T2 FS/SPIR
Coronal T1
Coronal STIR
Post contrast
Axial T1 FS
Coronal T1 FS
Sagittal oblique Lt T1 FS
Sagittal oblique Rt T1 FS
Axial DWI
	Head coil
	Slice thickness = 3 mm
	Slice gap = 0.5 mm
	FOV = 18 cm
	
	Axial = form occlusal plane to frontal sinus // optic nerve
	Coronal = form lens to mid-pons ⊥ optic nerve
	Sagittal oblique // optic nerve angle

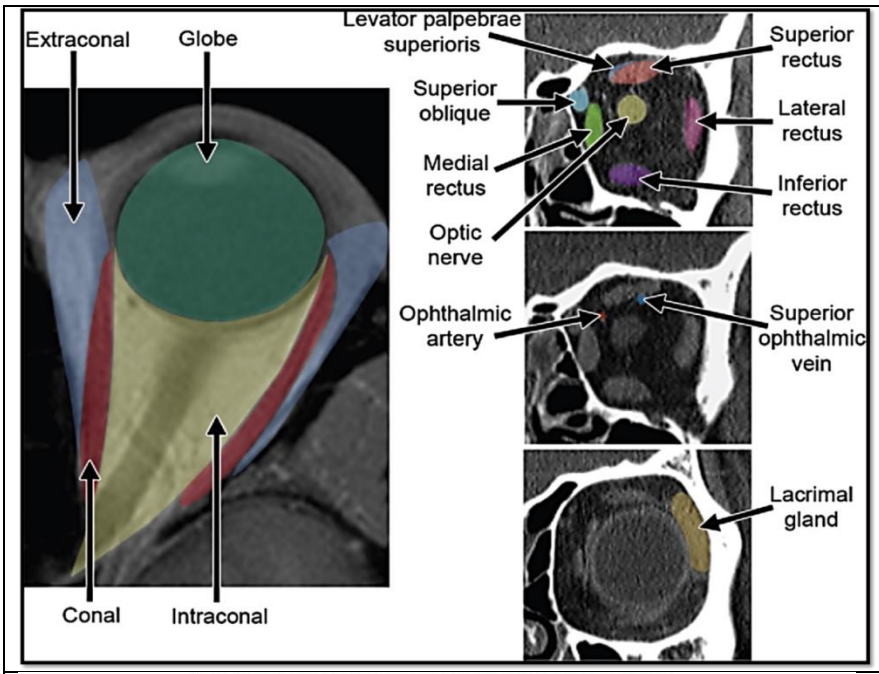
Axial

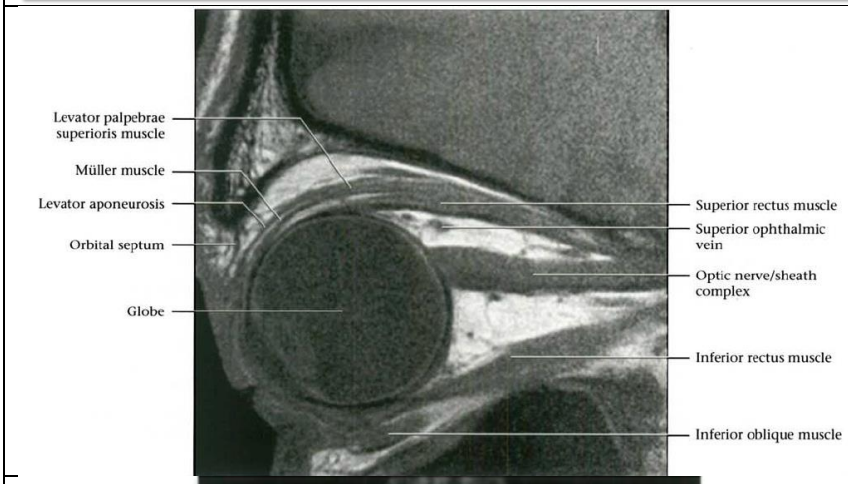


Coronal



Sagittal oblique Rt	Sagittal oblique Lt
	


Extraconal
Globe
Levator palpebrae superioris
Superior rectus
Superior oblique
Lateral rectus
Medial rectus
Inferior rectus
Optic nerve
Ophthalmic artery
Superior ophthalmic vein
Lacrimal gland
Conal
Intraconal


Levator palpebrae superioris muscle
Müller muscle
Levator aponeurosis
Orbital septum
Globe
Superior rectus muscle
Superior ophthalmic vein
Optic nerve/sheath complex
Inferior rectus muscle
Inferior oblique muscle

Anterior segment of eye
Vitreous chamber of eye
Medial & lateral rectus muscles
Optic nerve (intracanalicular segment)
Internal carotid artery
Lens
Perioptic fluid (CSF)
Optic nerve (intraorbital segment)
Optic nerve (chiasmatic segment)
Optic chiasm
Optic tract

I- GLOBE

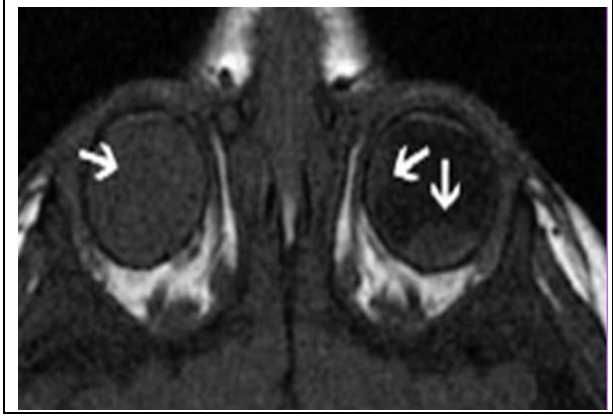
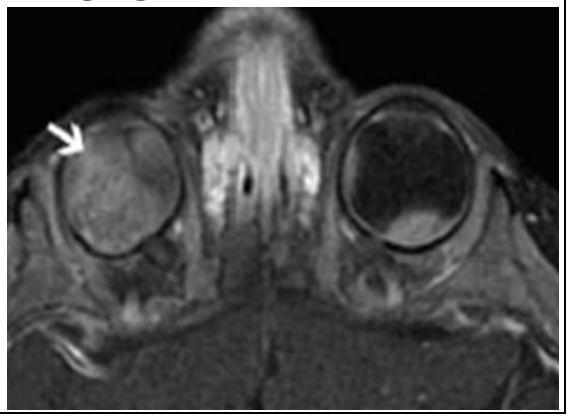
Pediatric = Leucokoria	Adult
1. Retinoblastoma 2. PHPV 3. Coat's disease 4. Retrolental fibrosis 5. Congenital cataract	1. Melanoma 2. Metastasis 3. Hemangioma 4. Hemangioblastoma (VHL) 5. Hamartoma (TS)

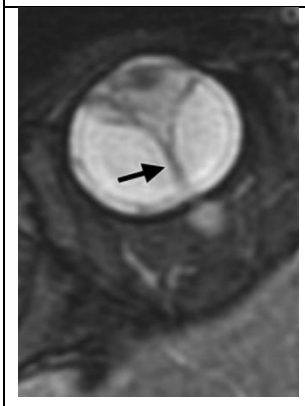
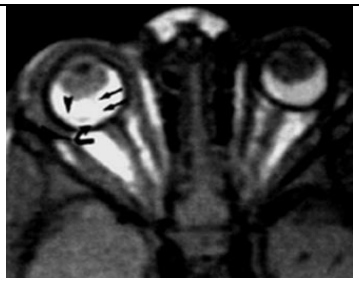
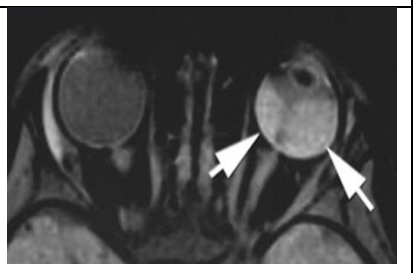
A) Pediatric = Leucokoria:

Leucokoria => Clinical sign = **White reflection of light back to the observer through the pupil.**	

1) Retinoblastoma:

- **Incidence :** Most common 1ry intra ocular tumor in child
- **Age**: < 3 yrs.
- **Associations:**
  - Multiple 30%
  - Bilateral 30%
  - Trilateral = bilateral + pineal body lesion (Pineoblastoma)
  - Tetralateral = trilateral + suprasellar lesion
  - Osteosarcoma
- **Growth patterns:**
  - Endophytic => grows into vitreous cavity.
  - Exophytic => grows into subretinal space.
  - Mixed
  - Infiltrative (rare)
- **Spread:**
  - Trans-scleral extension.
  - Optic Nerve Invasion.
  - Extra-ocular massive tumor spread
- **Radiological findings:**
  - Calcification in almost all cases
  - NCCT: Intra-occular dense lesion > vitreous
  - T1: high signal relative to vitreous
  - T2: low signal relative to vitreous.
  - +C: mild – moderate enhancement.

T1	**T1+C FS**
	

2) **Persistent hyperplastic primary vitreous (PHPV)**	3) **Retinopathy of prematurity (ROP)**	4) **Coat's disease**
Persistent hyperplastic embryonic primary vitreous hyaloid vessels	Premature baby received high pressure Oxygen therapy	Congenital nonhereditary, vascular malformation of the retina
Male infant	Premature baby	Male 6-8y
Unilateral	Bilateral	Unilateral
Microphthalmus		Normal sized eye
Distorted lens	Normal lens	Normal lens
A triangular or cone-shaped retrolental mass (low T1 signal).	Retrolental fibrosis (low T1 signal)	No retrolental mass
Vitreous hemorrhage High T1&T2 signal		Retinal telangectasia => Subretinal hemorrhage: High T1&T2 signal
A linear band or septum extending from the apex of the retrolental mass to the posterior pole of the globe.		V-shaped configuration of retinal detachment.
NCCT => Hyperdense T1&T2 => High signal NO Calcification NO Enhancement		
		

B)Adult:

1) Malignant Melanoma:

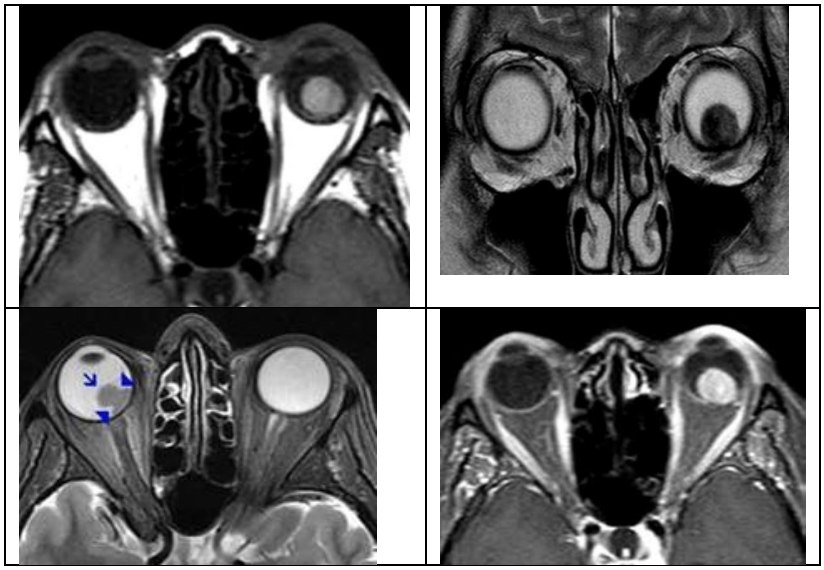
Incidence: *Most common (75%) ocular malignancy in adults.*
Age: 50-70 years
Site: unilateral posterior location:
85 % choroid
9% ciliary body
6% iris

Radiographic features

- Thickening or irregularity of choroids (localized, polypoid, or flat)
- Collar button configuration = biconvex mass lesion = erupt through Bruch's Membrane and extends through the vitreous chamber.
- Retinal detachment, common

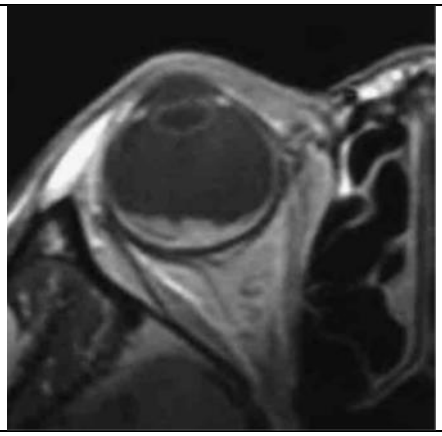
- NCCT: Hyperdense + No Calcification
- +C: Mild to moderate enhancement

- Melanotic melanoma → hyper T1 & hypo T2
- Amelanotic melanoma → Iso T1 & hypo T2



2) Choroidal Metastasis

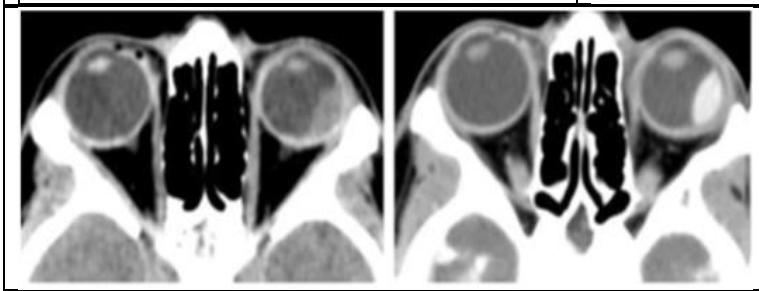
- The primary lesions that are the most common sources of uveal metastases are breast and lung carcinomas.
- Bilateral in about one-third of cases.

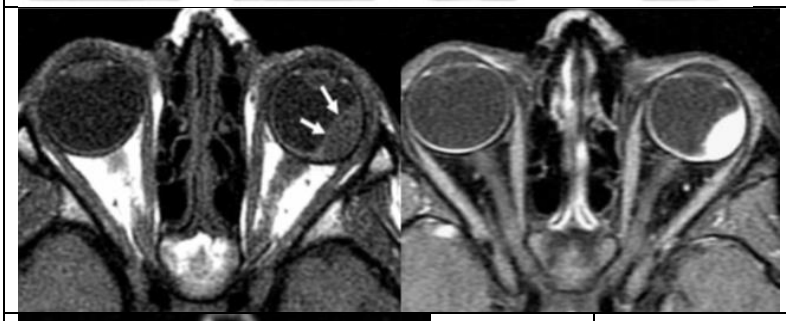


3) Choroidal hemangioma:

- Benign vascular neoplasm that is confined to the choroid.

- Lenticular shape
- T1: hyperintense to vitreous
- T2: isointense to vitreous.
- +C: The lesions enhance intensely





T2: Isointense to vitreous

(DD: melanoma is hypointense relative to vitreous)

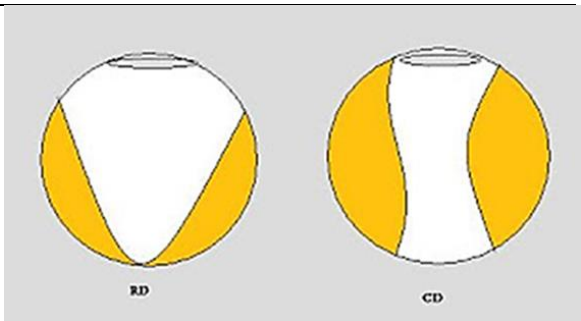
Detachement

Retinal detachment

- elliptical densities that have at their apex the optic nerve insertion to the globe.
- do not extend anteriorly beyond the level of the ora serrata. The ora serrata is generally seen at 10 o'clock and 2 o'clock on the globe and is proximal to the uveal apparatus.

Choroidal Detachment

- Biconvex location
- does not involve the optic nerve insertion to the globe.
- can extend further anteriorly than the retinal detachment.



Coloboma Vs Staphyloma

Coloboma

- Coloboma is any focal discontinuity in the structure of eye; Most commonly due to failure of closure of the choroidal fissure posteriorly.
- occurs along the inferomedial aspect of the globe and optic nerve

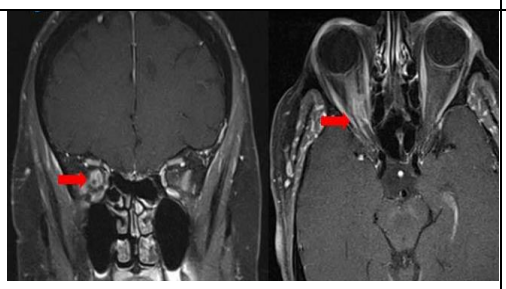
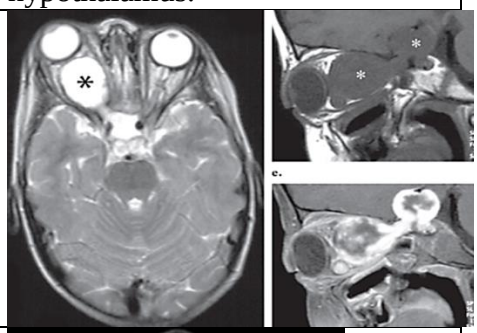
Staphyloma

- Staphylomas which are due to choroidal thinning.
- staphyloma defect is located off-center from the optic disc, typically temporal to the disc

RUPTURE GLOBE

1-Flat tire configuration of globe
2-Thickening of posterior sclera
3-Illdefined inner scleral margin
4-Intraocular air.

II- OPTIC NERVE

	OPTIC NERVE MENINGIOMA	OPTIC NERVE GLIOMA
	Arise from optic nerve sheath	Low grade pilocystic astrocytoma (WHO Grade I)
	Middle aged females	90% children < 20 years
Associations	NF- II	NF - I
Radiological findings	Enhancing tumor (arrows) surrounding the optic nerve. Axial => Tram-track sign Coronal => doughnut sign	Tubular / fusiform enlargement / tortuosity and kinking of the optic nerve. > 3mm difference compared with contralateral side
Calcification	Calcification	NO calcification
Bone	Sclerosis of optic canal & GWS.	
T1	Iso	Low
T2	Iso	High
+C	Marked homogenous enhancement	Mild – Moderate homogenous enhancement
Spread	Minimal extension of tumor through optic canal only into perichiasmatic optic nerve.	Intra-orbital segment of optic nerve => intra-cranial segment of optic chiasma => optic chiasma => Optic radiation => hypothalamus.
		

Optic Neuritis:

Clinical picture: Painful eye movement – loss of vision.

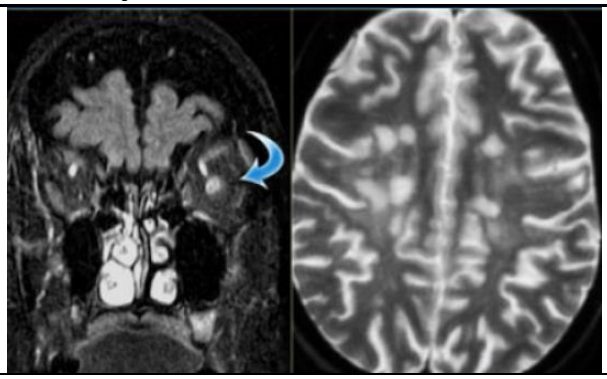
Associations:

1. Idiopathic
2. Multiple sclerosis (MS)
3. Neuromyelitis optica (NMO)
4. Acute disseminated encephalomyelitis (ADEM)
5. Systemic lupus erythematous (SLE)Orbital pseudotumor.
6. Sarcoidosis.
7. Viral infection e.g: herpes – varicella.
8. Radiation therapy

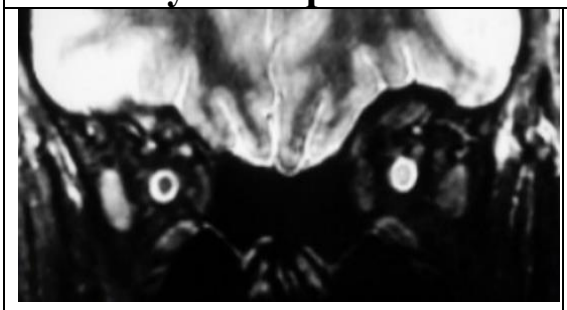
Radiological findings:

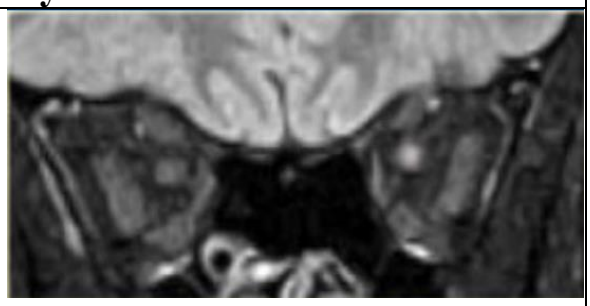
- T2 FS: Swollen optic nerve - high signal
- T1 postcontrast FS : Enhancement of optic nerve
- Obliteration of perioptic space
- No Masses.

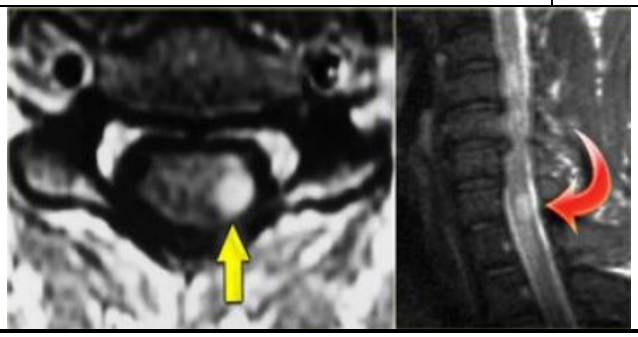
MS + Optic Neuritis

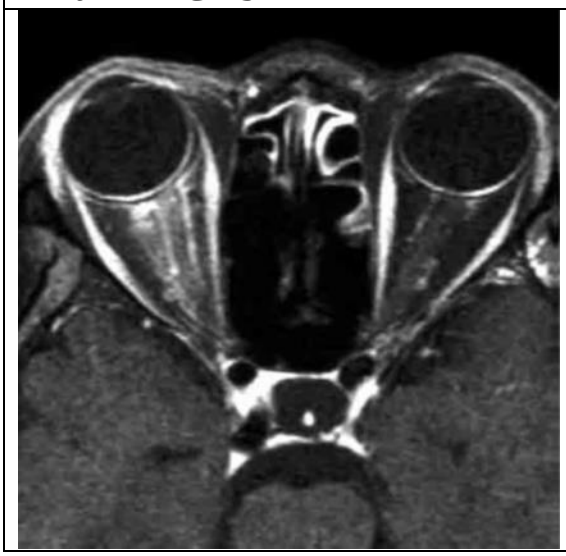


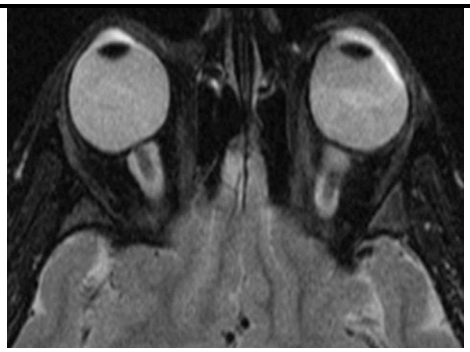
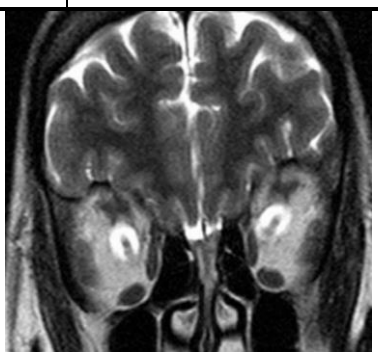
Neuromyelitis optica = Devic's Syndrome







Optic Perineuritis:	**CSF Tumor Dissemination**
unusual presentation of idiopathic orbital pseudotumor	most commonly seen in patients with breast and lung cancers
• Peripheral enhancement of the optic nerve sheath • Normal size + signal of the optic nerve	
Axial T1 +C FS	Coronal T1 +C FS
	

Dural Ectasia Of Optic Nerve Sheath:		
• CSF accumulation + Dilated sheath around the optic nerve	• Normal size + signal + enhancement of the optic nerve • Associations: **NF-I**	
		

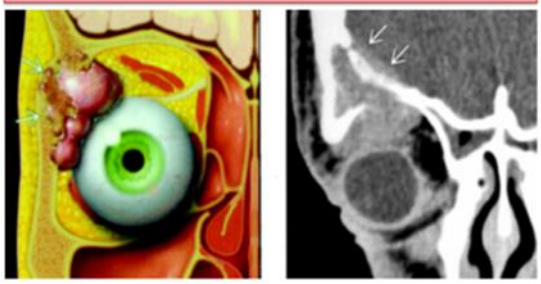
III- LACRIMAL GLAND

Unilateral	Bilateral
a) Inflammatory: 50% o Acute & chronic dacryoadenitis o Inflammatory Pseudo tumor **b) Neoplastic:** 50% ❖ **Benign tumors:** Pleomorphic adenoma - dermoid cyst ❖ **Malignant tumors:** Carcinoma – Lymphoma – Metastasis.	**Manifestation of systemic disease** 1) Lymphoma 2) AML choloroma 3) Sarcoidosis 4) Sjogren's syndrome 5) Mikulicz's syndrome 6) Myxoedema 7) Wagener's ganuloma 8) Amyloidosis 9) Grave's disease

Pleomorphic Adenoma

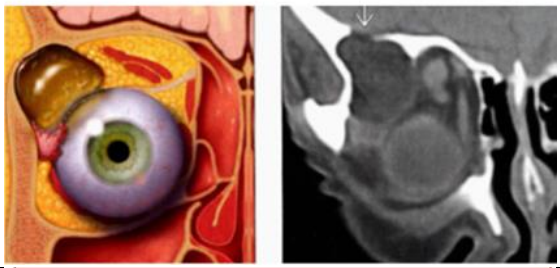
Most common benign neoplasm of lacrimal gland
A well defined moderately enhancing mass
Scalloped remodeling of lacrimal fossa.

ADENOID CYSTIC CARCINOMA

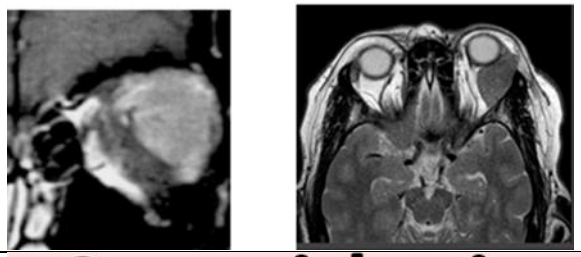


Most common malignant neoplasm of lacrimal gland
Invasive lacrimal mass + destruction of orbital roof + perineural spread

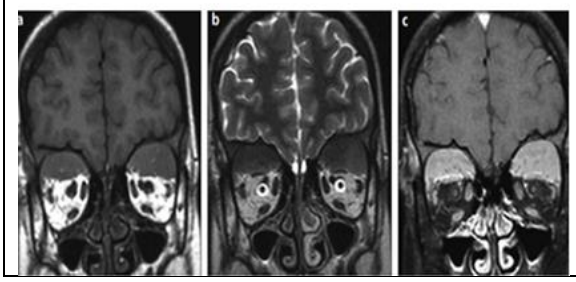
Orbital Dermoid



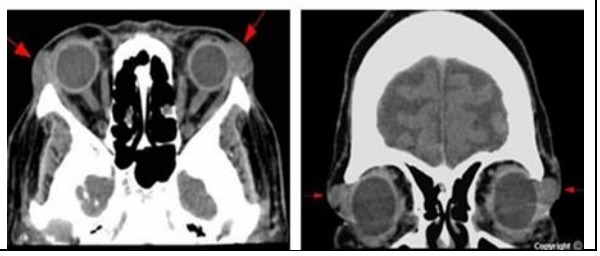
Orbital NHL



AML Choloroma



Sarcoidosis



IV- EOM

A) Multiple Muscles :	B) Single Muscle :
Grave ‘s disease Orbital pseudotumor	Orbital pseudotumor
	1ry Tumors: Rhabdomyosarcoma – Lymphoma 2ry neoplasm: → direct extension from orbital or sinus tumor → Blood born from breast,…..

1) Thyroid Ophthalmopathy = Grave’s disease:

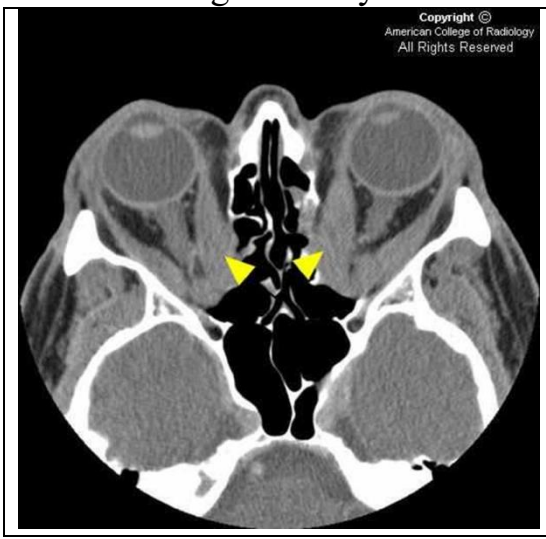
- Bilateral > Unilateral

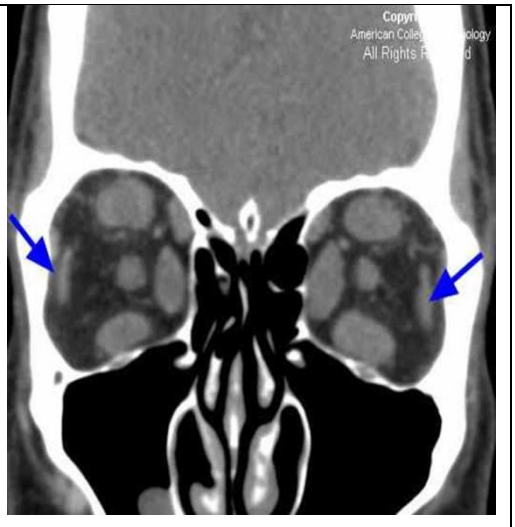
Radiological findings:

- Bilateral symmetrical muscle enlargement is most frequent
- IR > MR > SR > LR
- Fusiform enlargement of EOMs + strong enhancement.
- Sparing tendinous insertion

All orbital contents (fat, optic nerve, lacrimal gland) can be affected:

- Fat ↑ volume + dirty fat → **Proptosis**
- Optic neuropathy due to compression &/or involvement of optic nerve
- Lacrimal gland & eye lid → swelling.





2) Orbital Inflammatory Pseudotumor:

- Idiopathic inflammation
- Unilateral > Bilateral

Any part of the orbit:

- EOM = Muscles + Tendons
- **Lateral rectus muscle**
- Lacrimal gland
- Orbital fat
- Optic perineuritis
- Posterior scleritis

- Diagnosis of Exclusion
- Rapid response to steroids support diagnosis
- Intracranial extension = Tolosa hunt Syndrome
- Ig4- Related Systemic Disease = Ig4-RSD

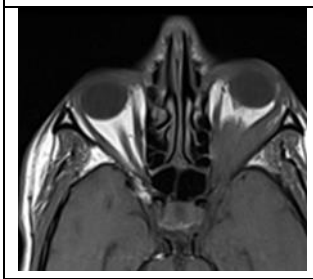
Tolosa Hunt syndrome

- The Tolosa Hunt syndrome (THS) is an idiopathic inflammatory condition that involves the cavernous sinus and orbital apex => painful ophthalmoplegia.
- Retro-orbital pain + CN III, IV, VI palsy.

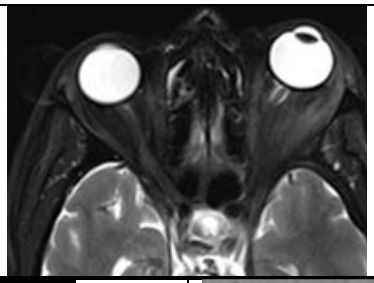
IgG4 Related Systemic Disease (IgG_4-RSD)

- Systemic disease that is characterized by extensive IgG4-positive plasma cells and T-lymphocyte infiltration of various organs
- Pancreatitis, sclerosing cholangitis, cholecystitis, sialadenitis, retroperitoneal fibrosis, tubulointerstitial nephritis, interstitial pneumonia, prostatitis, inflammatory pseudotumor and lymphadenopathy, are all thought to be IgG4-related
  - The prototype is IgG4-related sclerosing pancreatitis (also known as autoimmune pancreatitis)
- Disease usually responds well to steroid therapy

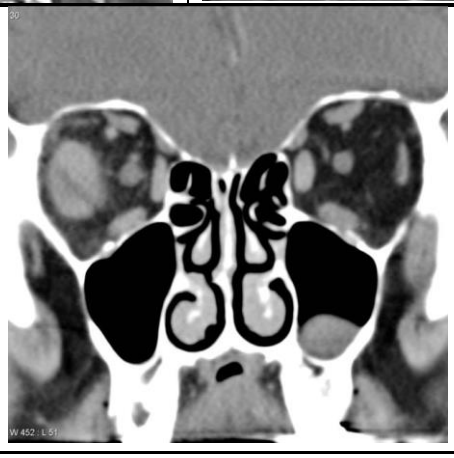
Axial T1



Axial T2 FS



Axial T1 +C FS



V- ORBITAL FAT LESIONS

Diffuse intra / extra- conal +C	Dilated veins
• Orbital infection • Orbital pseudotumor • Lymphoma / Leukemia • Wegner granulomatosis • Sarcoidosis • NF – I • Capillary / infantile hemangioma • Venolymphatic malformation	• Ophthalmic vein thrombosis • Carotid-cavernous fistula • Orbital Varices • Orbital AVM
Localized intra-conal + C	**Localized intra-conal - C**
• Cavernous hemangioma • Schwannoma /Neurofibroma • Lymphoma • Metastasis	• Lymphangioma
Localized Exta-conal Adult	**Localized Exta-conal Pediatric**
• Hemangiopericytoma • Schwannoma /Neurofibroma • Metastasis	• RMS • Metastasis (NB – Wilm's Tumor – Ewing Sarcoma)

A- Diffuse Orbital Lesions :

1) Infantile Capillary Hemangioma

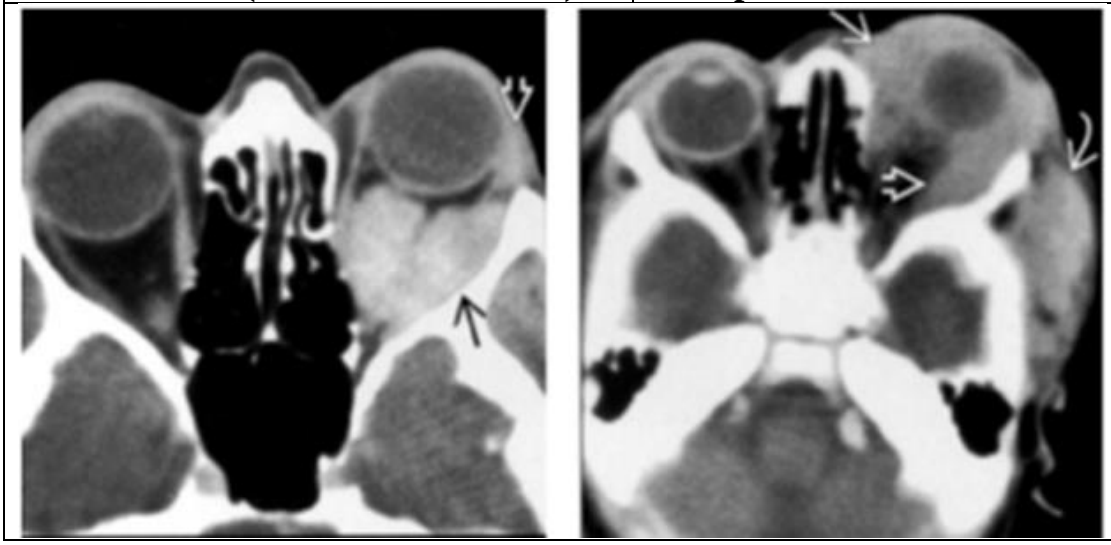
- Appear within first 6m after birth
- Proliferative phase = rapidly increase in size for 6-12m
- Involuting phase = gradually involute over 7-10y

Radiological features:

Lobulated lesion + Thin septa

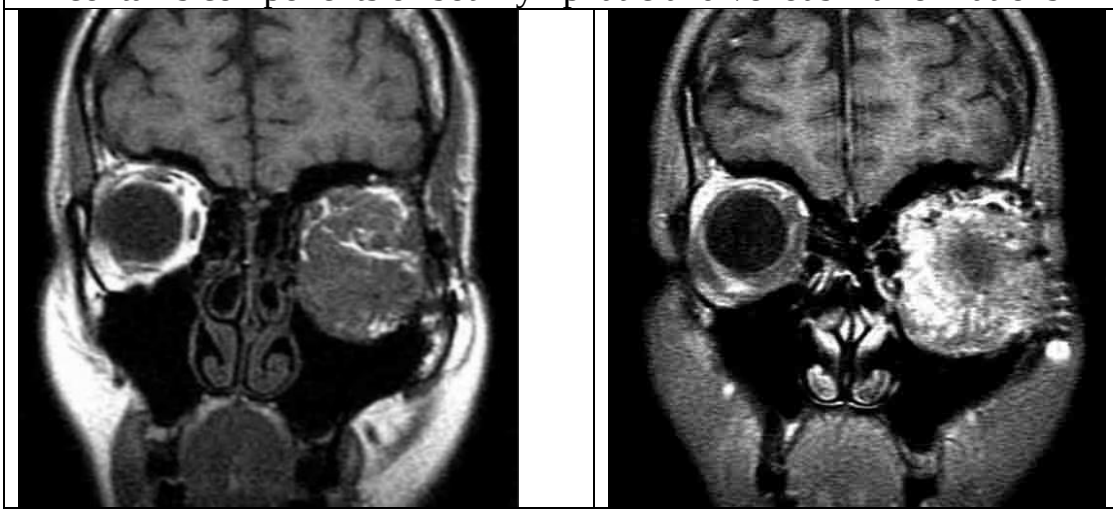
Intense enhancement

Rertrobulbar (intra & extra-conal)	**Preseptal**



2) Orbital Venolymphatic Malformation

- Low-flow type vascular malformation
- contains components of both lymphatic and venous malformations



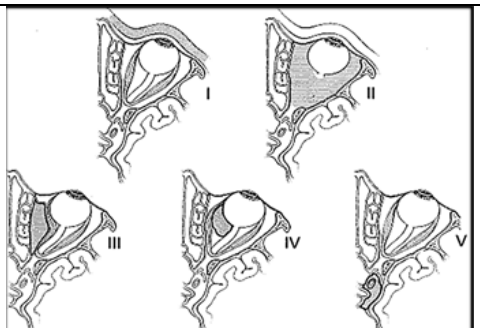
3) Neurofibromatosis NF-I

- Sphenoid dysplasia + Arachnoid cyst
- Optic nerve glioma
- Buphthalmos
- Multiple plexiform neurofibromas

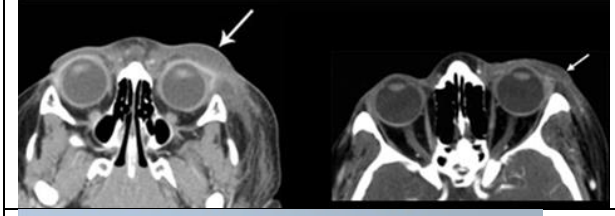
4) ORBITAL INFECTIONS

CHANDLER'S CLASSIFICATION OF THE ORBITAL COMPLICATIONS OF ACUTE SINUSITIS

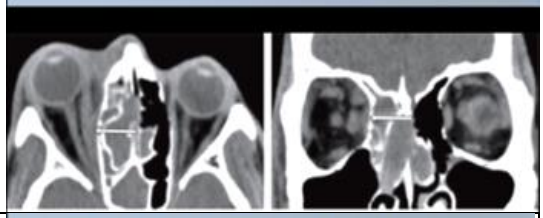
- **Group I** : Preseptal cellulitis = Periorbital cellulitis
- **Group II** : Postseptal cellulitis = Orbital cellulitis
- **Group III** : subperiosteal abscess
- **Group IV** : intraorbital abscess,
- **Group V** : cavernous sinus thrombosis.



PRESEPTAL CELLULITIS = (PERIORBITAL CELLULITIS)



SUBPERIOSTEAL ABSCESS DUE TO ETHMOIDAL SINUSITIS

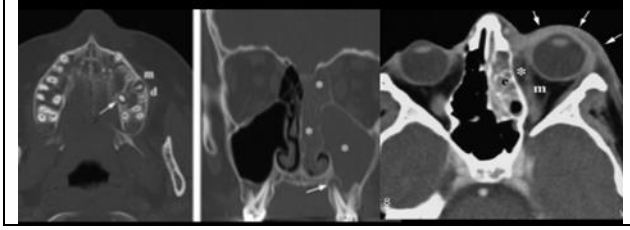


PERIORBITAL (ARROW HEAD) + ORBITAL (ARROWS) CELLULITIS

OPHTHALMIC VEIN THROMBOSIS CAVERNOUS SINUS THROMBOSIS

ODONTOGENIC ORBITAL CELLULITIS

Peri-apical infection => Maxillary and ethmoidal sinusitis => Subperiosteal abscess + preseptal and postseptal cellulitis



ENDOPHTHALMITIS

- is an intraocular inflammatory process which can be the result of trauma or infection of the eye.
- Predisposing factors:
  - Diabetics,
  - Debilitating diseases
  - Immmunosuppressed

5) Orbital Pseudotumor:

- Idiopathic inflammation
- Unilateral > Bilateral

<u>Any part of the orbit:</u>

- EOM = Muscles + Tendons
- **Lateral rectus muscle**
- **Lacrimal gland**
- **Orbital fat**
- **Optic Perineuritis**
- **Posterior scleritis**

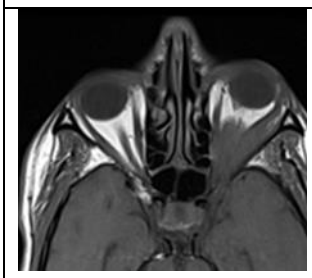
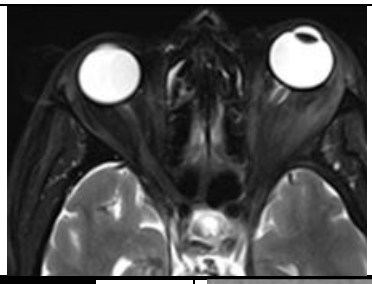
- Diagnosis of Exclusion
- Rapid response to steroids support diagnosis
- Intracranial extension = Tolosa hunt Syndrome
- Ig4- Related Systemic Disease = Ig4-RSD

Tolosa Hunt syndrome

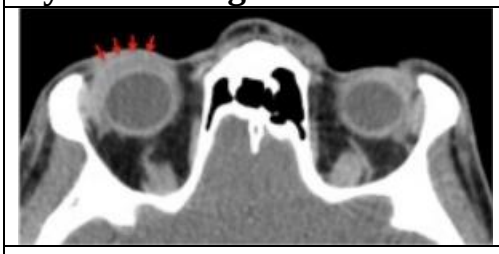
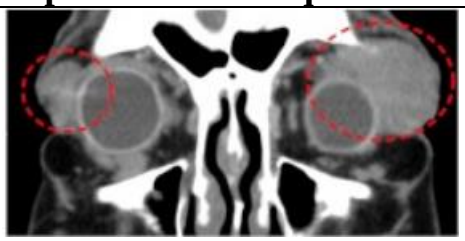
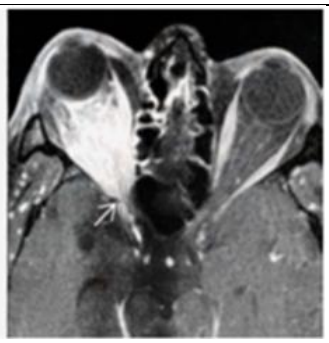
- The Tolosa Hunt syndrome (THS) is an idiopathic inflammatory condition that involves the cavernous sinus and orbital apex => painful ophthalmoplegia.
- Retro-orbital pain + CN III, IV, VI palsy.

IgG4 Related Systemic Disease (IgG_4-RSD)

- Systemic disease that is characterized by extensive IgG4-positive plasma cells and T-lymphocyte infiltration of various organs
- Pancreatitis, sclerosing cholangitis, cholecystitis, sialadenitis, retroperitoneal fibrosis, tubulointerstitial nephritis, interstitial pneumonia, prostatitis, inflammatory pseudotumor and lymphadenopathy, are all thought to be IgG4-related
  - The prototype is IgG4-related sclerosing pancreatitis (also known as autoimmune pancreatitis)
- Disease usually responds well to steroid therapy

Axial T1	Axial T2 FS	Axial T1 +C FS
		

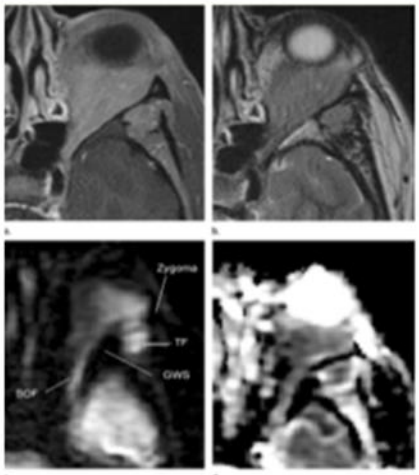
6) Orbital Lymphoma:

• NHL • Conjuctiva, eye lids, lacrimal glands. • Retrobulbar space • Superior + Lateral quadrants •	• NCCT: Homogenous density • T1: Hypointense • T2: Isointense • +C: Homogenous moderate contrast enhancement • DWI: Restricted • ADC: Low
Eye lid homogenous soft tissue sheet:	**Superior+Lateral quadrants**
	
Retrobulbar / Intraconal space	**Intra+Extra- conal +Preseptal**
	

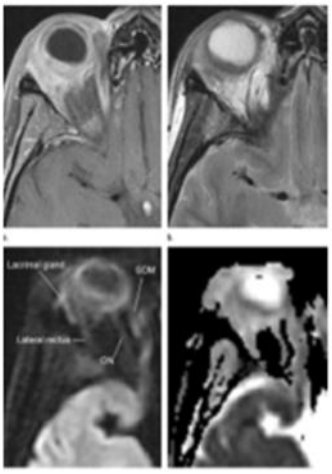
DD: Orbital Lymphoma VS Orbital Pseudotumor

- Lymphomas has lower ADCs than pseudotumors
- ADC cut off value = 1.0 X10^{-3} mm^2 /sec

Orbital Lymphoma:
ADC < 1.0 X10^{-3} mm^2 /sec



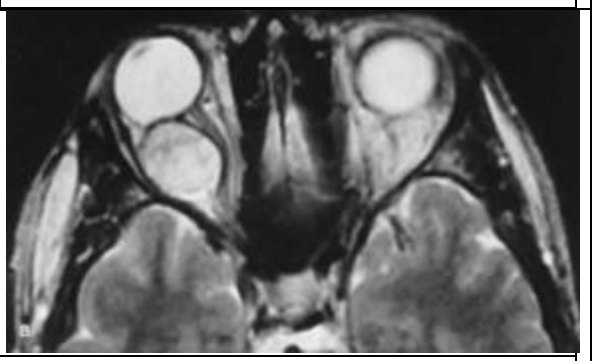
Orbital Pseudotumor:
ADC > 1.0 X10^{-3} mm^2 /sec



B- Localized Intra-conal Adult Lesions :

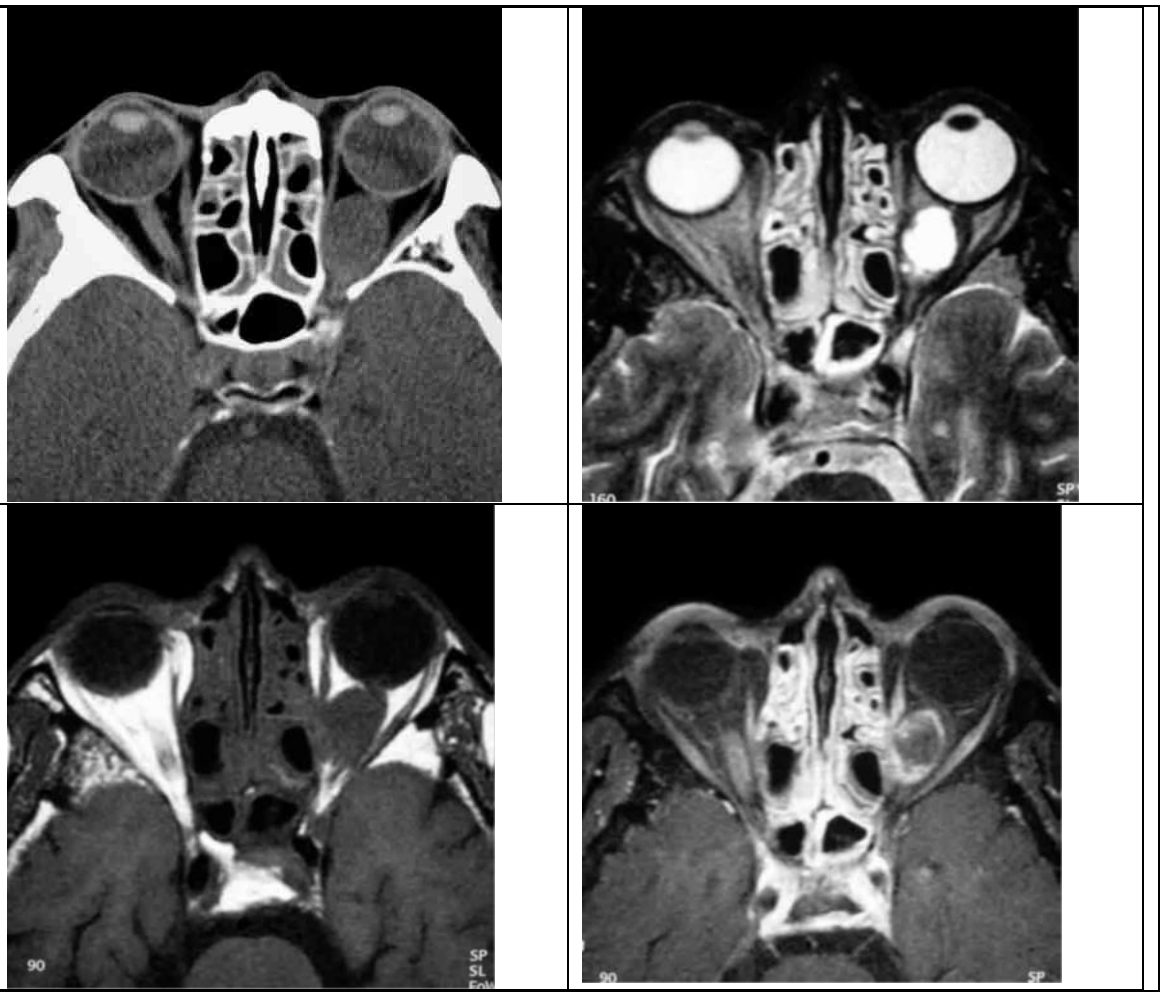
1) Cavernous Hemangioma

Most common vascular lesion in adults. F >>> M Middle age adults Slowly progressive enlargement.	**Radiological features:** Well defined lesion Retro-bulbar intra-conal NCCT: Hyperdense T1: Hypo T2: Marked high signal +C: Marked homogenous enhancement

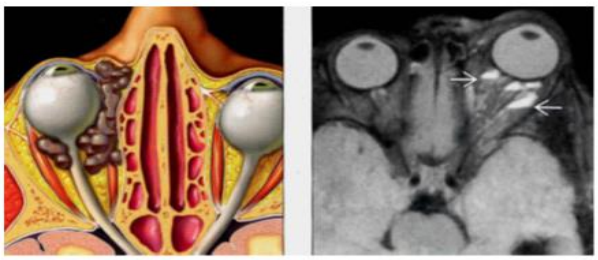


2) Schwannoma:

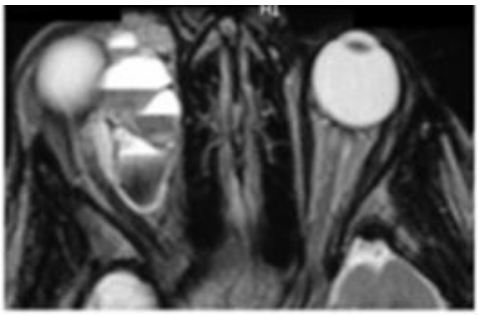
• Rare • Middle age • F > M • Arise from branches of the trigeminal nerve • Most common: Frontal branch of branch of the ophthalmic nerve	**Radiological findings:** • Well defined • Ovoid shaped lesion • T1: Low signal • T2: High signal • +C: Faint enhancement



LYMPHANGIOMA



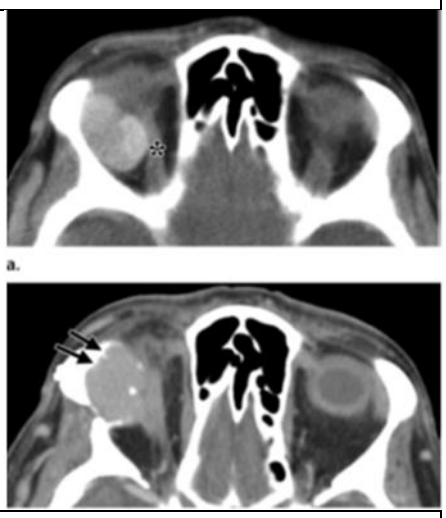
T2: Lobulated, very hyperintense fluid signal
Multilocular, Fluid/ Fluid level



C- Localized Extra-conal Adult Lesions :

1) Hemangiopericytoma

- Rare neoplasm (1% of all orbital tumors)
- Age: old age Adults
- Well defined – Lobulated lesion
- Extra-conal.
- Intense homogenous enhancement
- Aggressive => Bone erosion



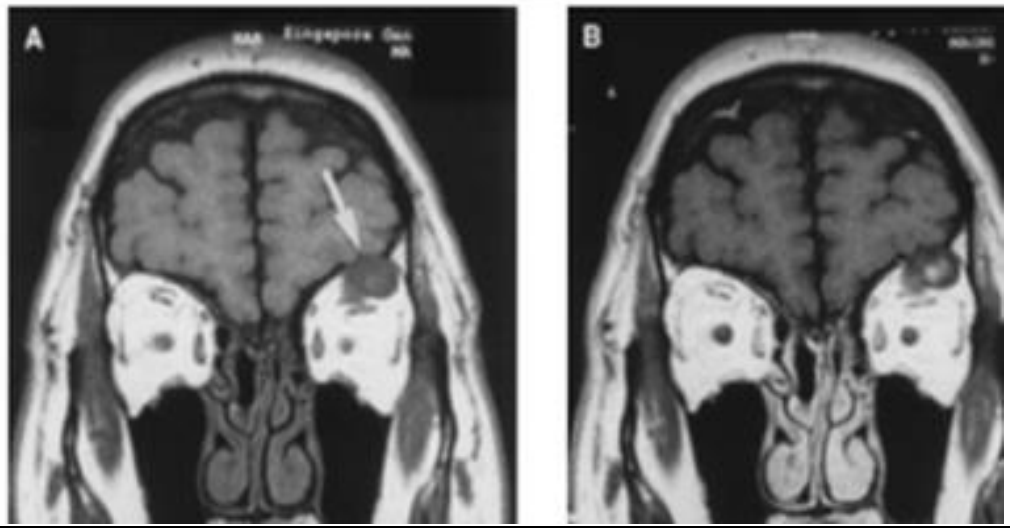
2) Schwannoma:

- Rare
- Middle age
- F > M
- Arise from branches of the trigeminal nerve
- Most common: Frontal branch of branch of the ophthalmic nerve

Radiological findings:

- Well defined
- Ovoid shaped lesion
- T1: Low signal
- T2: High signal
- +C: Faint enhancement

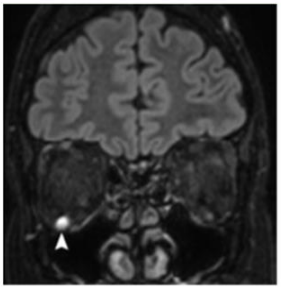
Ophthalmic Nerve Schwannoma
Extra-conal superior portion of orbit



3) Neurofibroma:

- Neurofibromas are benign, slow-growing, peripheral nerve tumors
- Localized, diffuse, and plexiform types may occur in the orbit.
- Plexiform neurofibromas are the most common type of peripheral nerve sheath tumor and are essentially pathognomonic for NF-1.

Neurofibroma of V2 Maxillary division of trigeminal nerve in infra-orbital canal



2) Metastasis

- Orbital metastasis is a significant cause of orbital disease in adults and accounts for 3-10% of all orbital tumors.
- ***Pediatric*** metastatic orbital tumors: Embryonal tumors, neuroblastomas, Ewing's sarcomas and Wilms tumors
- ***Adult*** metastatic orbital tumors: are predominantly from breast, lung, and prostate carcinomas.
- ***Breast cancer*** accounts for the majority of ocular and orbital metastases

D-Localized Extra-conal Pediatric Lesions :

1) Rhabdomyosarcoma

Most common pediatric soft tissue sarcoma

Age: Children (70-80% <10 y)
Sex: M > F
Location: H&N 40%

Primary location in H&N:

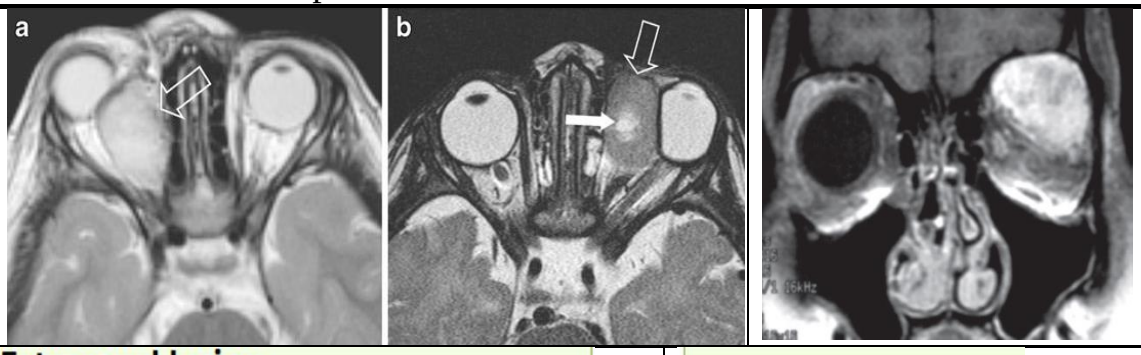
- Parameningeal (PM) 50%
- Nonparameningeal (NPM) 25%
- Orbital (ORB) 25%

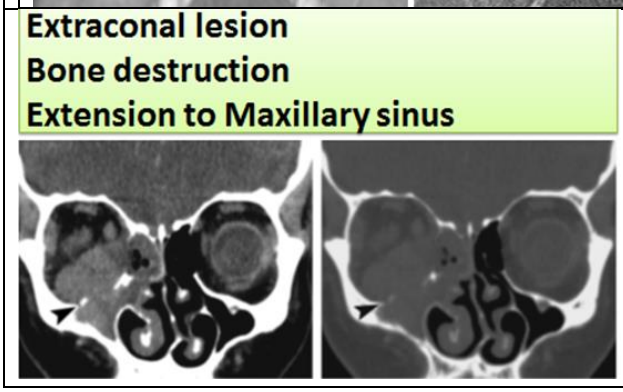
Pathology:

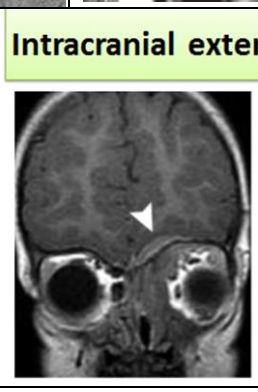
- Embryonal
- Alveolar
- Pleomorphic

Radiological Features:

Intraorbital **Extra** > Intra - conal
Aggressive ill defined soft tissue lesion
T1: Low signal
T2: Heterogeneous high signal
+C: Heterogeneously enhancement
Bone destruction
Invasion of adjacent fascial planes/spaces
± Intracranial extension
± Perineural tumor spread







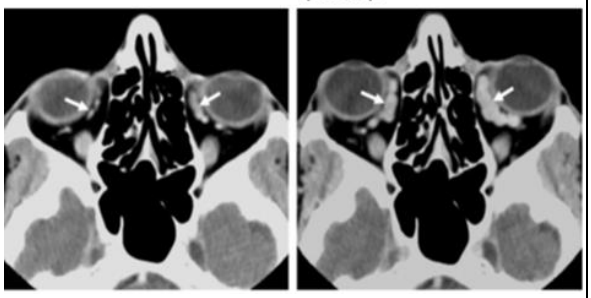
E- Dilated veins

Orbital Varices

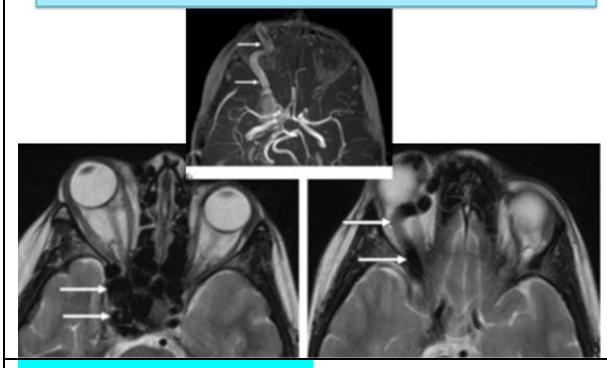
- Varices are the most common cause of spontaneous orbital hemorrhage

At rest

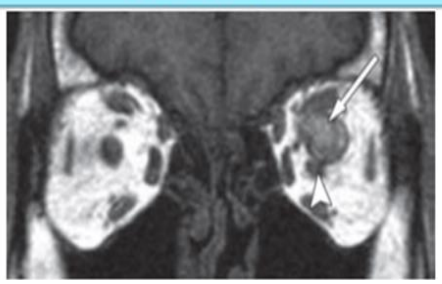
During valsalva maneuver shows the marked distention typical of orbital varices (arrows).



Carotid Cavernous Fistula



Superior Ophthalmic Vein Thrombosis



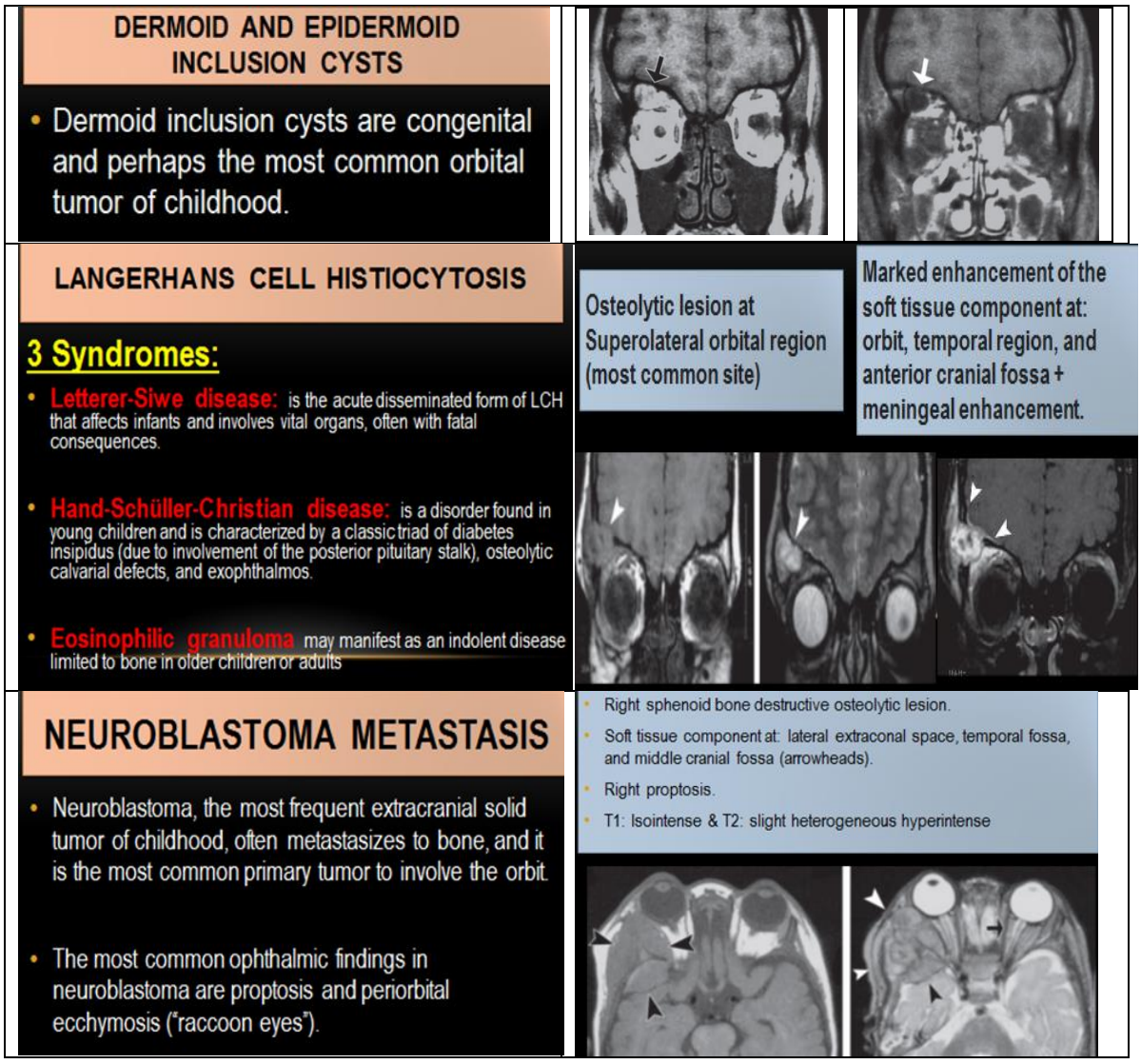
Orbital AVM:

Early phase: Dilated right ophthalmic artery (arrowheads).	Late phase: rapid filling of the large intracranial venous component of the malformation (arrows).

VI- ORBITAL BONY LESIONS

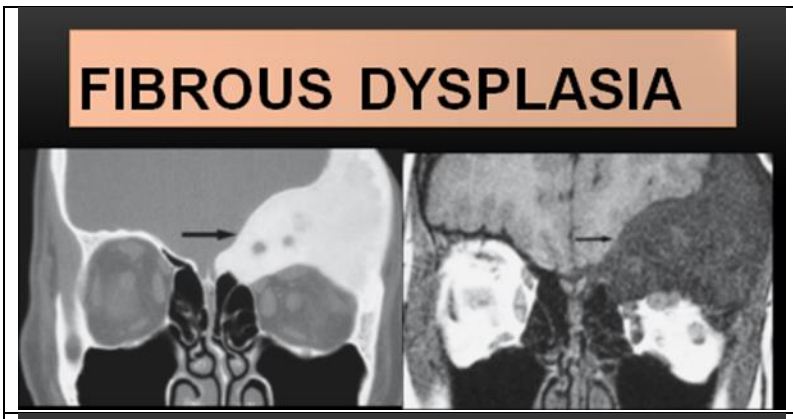
A) Lytic lesions:

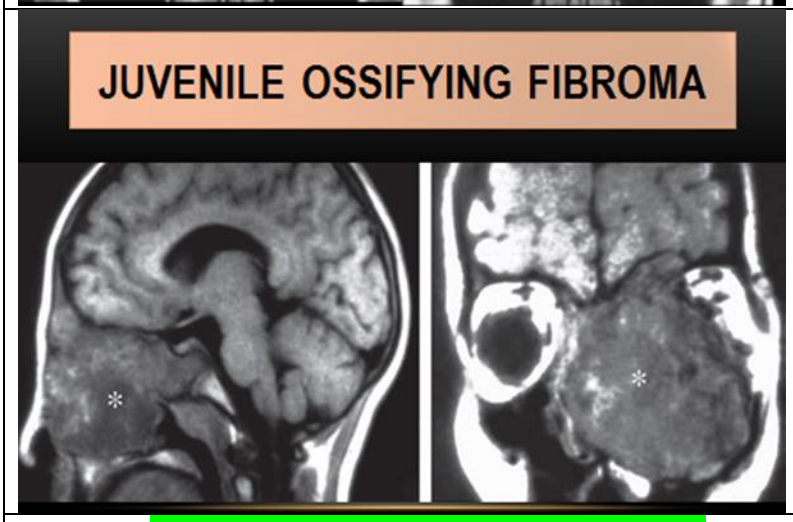
- Congenital defect in GWS seen in neurofibromatosis & enchephalocele.
- Pressure erosion by long standing lesions (Dermoid cyst)
- Destruction by orbital tumor.
- Destruction by direct extension from nearby areas
- Destruction by metastatic deposits:
  - Old → breast- lung- kidney
  - Child → neuroblastoma- Ewing sarcoma.


DERMOID AND EPIDERMOID INCLUSION CYSTS
• Dermoid inclusion cysts are congenital and perhaps the most common orbital tumor of childhood.
LANGERHANS CELL HISTIOCYTOSIS
3 Syndromes:
• Letterer-Siwe disease: is the acute disseminated form of LCH that affects infants and involves vital organs, often with fatal consequences.
• Hand-Schüller-Christian disease: is a disorder found in young children and is characterized by a classic triad of diabetes insipidus (due to involvement of the posterior pituitary stalk), osteolytic calvarial defects, and exophthalmos.
• Eosinophilic granuloma may manifest as an indolent disease limited to bone in older children or adults
Osteolytic lesion at Superolateral orbital region (most common site)
Marked enhancement of the soft tissue component at: orbit, temporal region, and anterior cranial fossa + meningeal enhancement.
NEUROBLASTOMA METASTASIS
• Neuroblastoma, the most frequent extracranial solid tumor of childhood, often metastasizes to bone, and it is the most common primary tumor to involve the orbit.
• The most common ophthalmic findings in neuroblastoma are proptosis and periorbital ecchymosis ("raccoon eyes").
• Right sphenoid bone destructive osteolytic lesion.
• Soft tissue component at: lateral extraconal space, temporal fossa, and middle cranial fossa (arrowheads).
• Right proptosis.
• T1: Isointense & T2: slight heterogeneous hyperintense

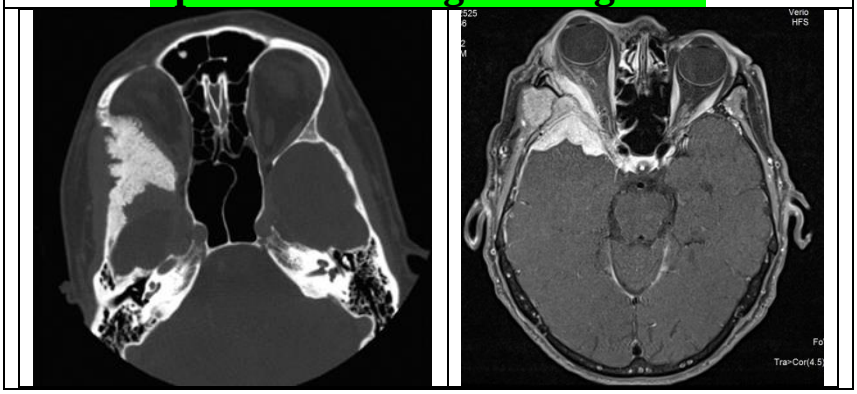
B) Sclerotic deposits:

- Fibrous dysplasia
- Meningioma en plaque
- Paget's disease
- Sclerotic deposits.





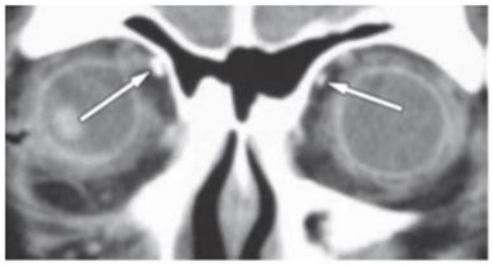
Sphenoidal Wing Meningioma



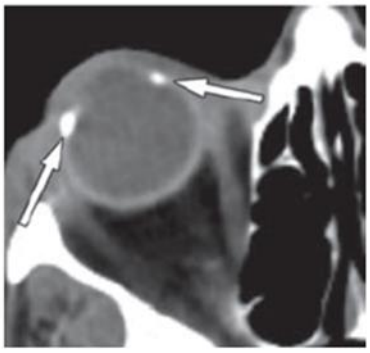
Orbital Calcifications

Optic Drusen

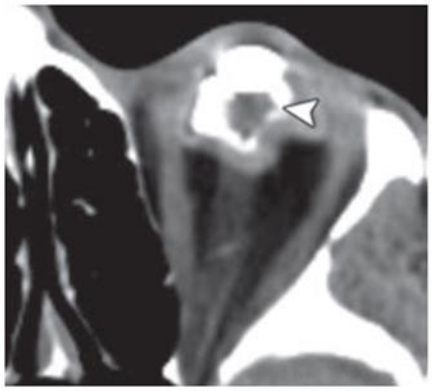
Trochlear Calcification



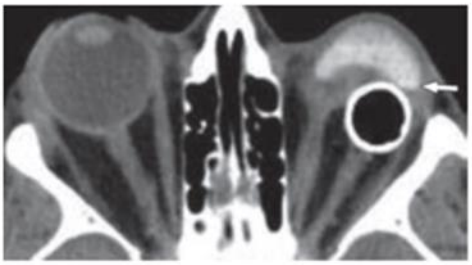
Scleral Plaques



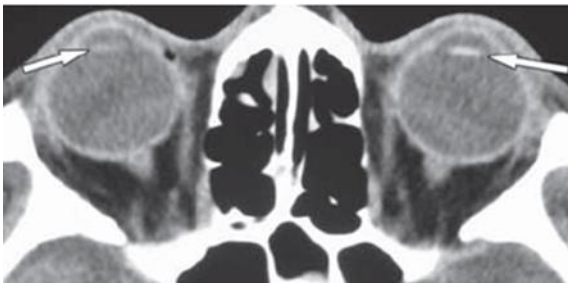
Phthisis Bulbi



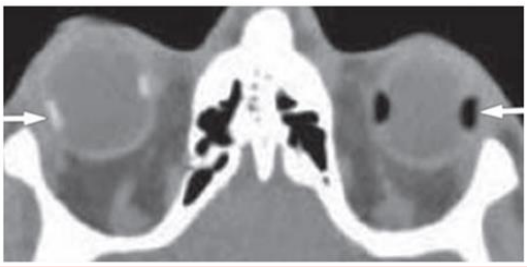
2 Piece Globe Prosthesis



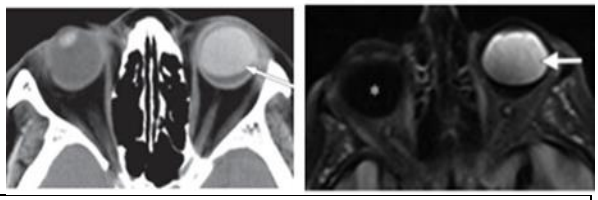
Intraocular Lens Implant



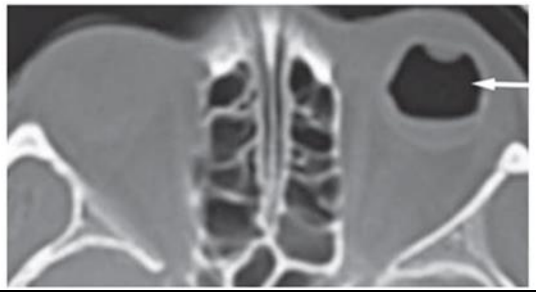
Scleral Buckle Device in RD

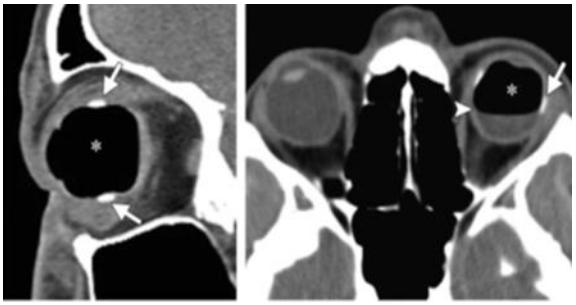


Silicone Oil Tamponade in RD



Pneumatic Retinopexy in RD





Sinonasal Cavity

List of Contents
Sinusitis
Benign Lesions
Malignant Lesions
Bony Lesions
Cystic Lesions
Nasal septum
Nasal cavity

Anatomy

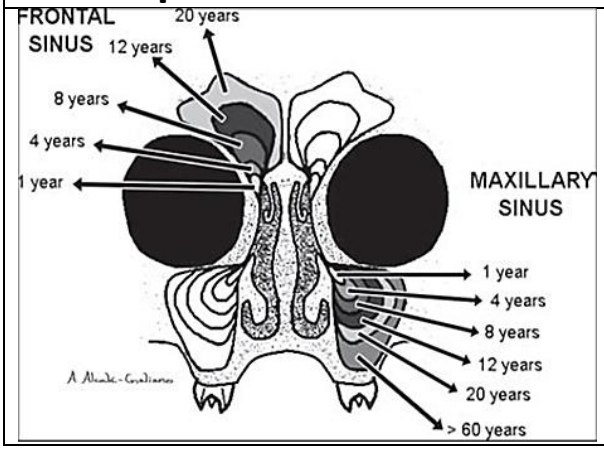
PNS

- Air filled spaces in the skull
  - Humidification
  - Warming
  - Removal of particulate from air
- Sinuses:
  - Maxillary sinus
  - Ethmoid sinus
  - Frontal Sinus
  - Sphenoid Sinus

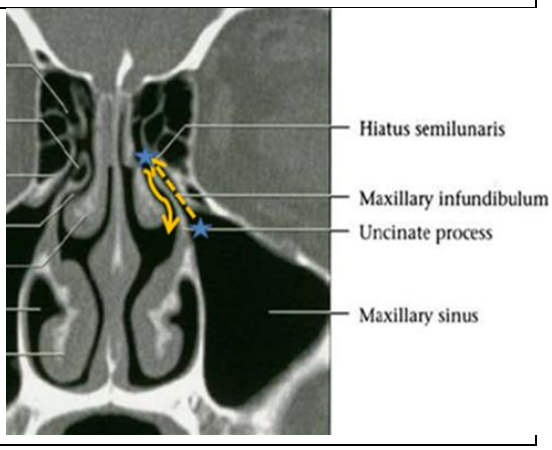
Nasal Cavity

- Nasal septum:
  - Bony septum
    - Perpendicular plate of ethmoid
    - Vomer
  - Cartilage septum
- Roof: Cribriform plate
- Floor: Hard and soft palate
- Lateral: 3 Turbinates & meatii
  - Superior turbinate & meatus
  - Middle turbinate & meatus
  - Inferior turbinate & meatus

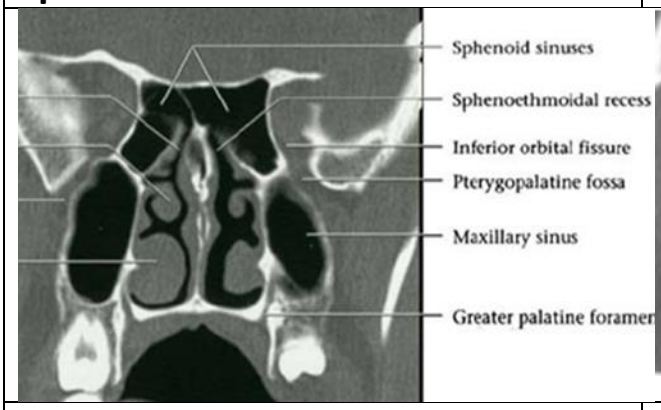
Developmental



OMC Unit

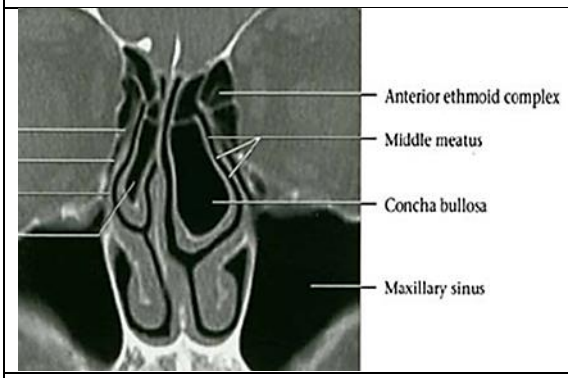


Spheno-ethmoidal Recess

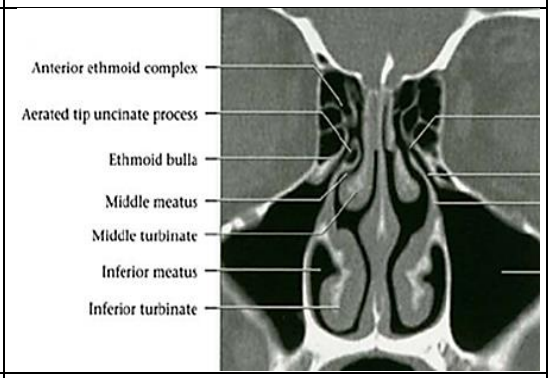


Fronto-ethmoidal Recess

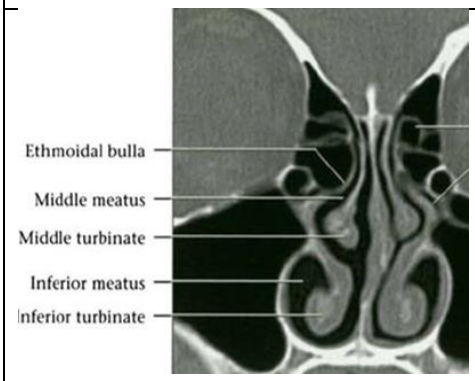
Concha Bullosa



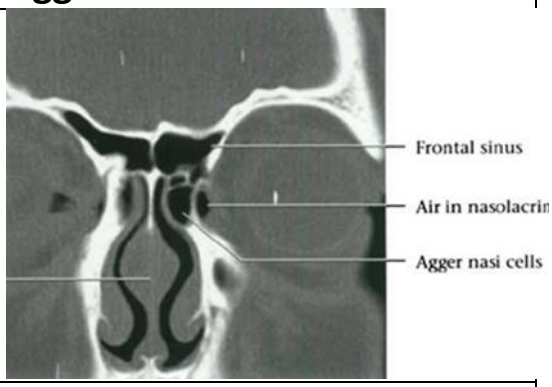
Areated tip of Uncinate Process



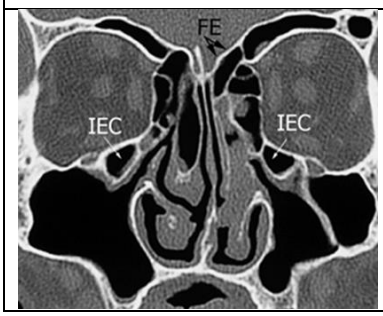
Ethmoidal Bulla



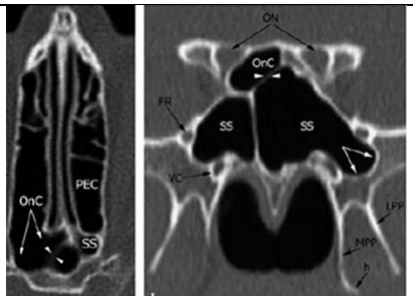
Agger Nasi Cells



Infraorbital Ethmoidal air Cells
Haller Cells



Spheno-ethmoidal Cells
Onodi cells



PNS Technique

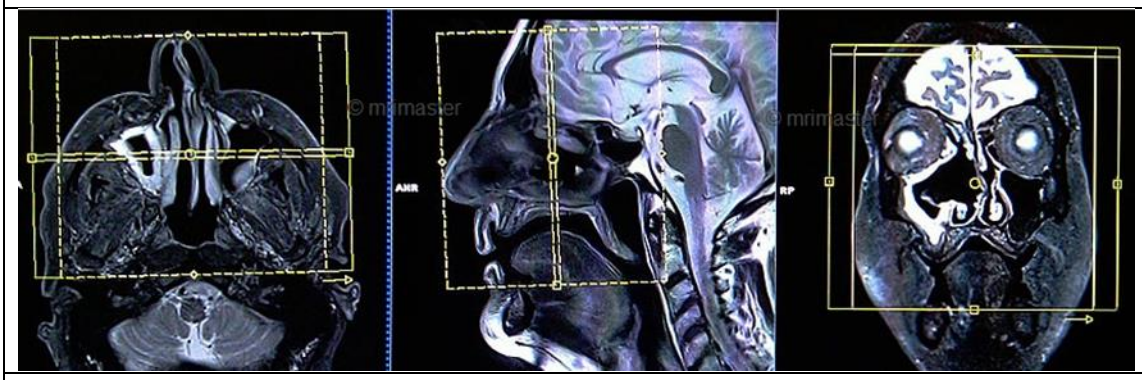
CT Protocol

Axial & Coronal Bone Window
Axial & Coronal Soft tissue window

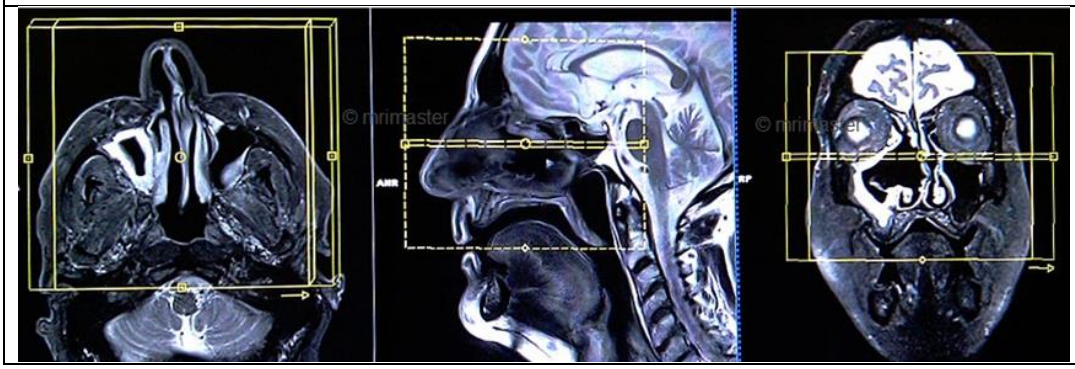
MRI Protocol

Axial T2 of the brain	Head coil
	FOV = 16 – 18 cm
Axial T1	Slice thickness = 3mm
Axial T2 FS/SPIR	Slice gap = 0.5 mm
Coronal T1	From nose tip to brain stem
Coronal STIR	From top of frontal sinus to lower lip
	Coronal
Post contrast	⊥ Hard palate
Axial T1 FS	// Nasal septum
Coronal T1 FS	**Axial**
Sagittal T1 FS	// hard palate
Axial DWI	⊥ Nasal septum

Coronal



Axial



RhinoSinusitis

- **Acute Sinusitis:**
  - **Complications:**
    - **Intracranial complications**
    - **Intraorbital complications**
    - **Superficial complications**
    - **Odontogenic Sinusitis**
- **Chronic Sinusitis**
  - **6 Patterns:**
    - **Maxillary infundibular pattern**
    - **Frontoethmoidal recess pattern**
    - **Sphenoethmoidal recess pattern**
    - **Ostiomeatal pattern**
    - **Pansinusitis with sinonasal polyposis**
    - **Sporadic pattern**
- **Fungal Sinusitis**
  - **3 Invasive:**
    - **Acute invasive**
    - **Chronic invasive**
    - **Chronic granulomatous**
  - **2 Non-invasive**
    - **Allergic fungal sinusitis**
    - **Fungal ball (Mycetoma)**
- **Atrophic Rhinitis:**
  - **Primary = Idiopathic**
  - **Secondary**
- **Silent Sinus Syndrome**
- **Nasal polyps:**
  - **Ethmoidal polyp**
  - **Antrochoanal polyp**
  - **Spehnochoanal polyp**

Rhinosinusitis

- is an inflammation of the mucosa of the nose and paranasal sinuses.
- It is classified according to duration of symptoms as:
  - ❖ **Acute < 4 w**
  - ❖ **Subacute = 4 – 12 w**
  - ❖ **Chronic > 12 w**

Acute Sinusitis

- Acute and subacute sinusitis < 12 w
- Patients with acute rhinosinusitis commonly complain of nasal obstruction, rhinorrhea, headache, facial pain, and dysosmia

Radiological features:

- **Peripheral mucosal thickening**
- **Air/Fluid levels**
- **Air bubbles within fluid**
- **Obstruction of OMC.**

T1:

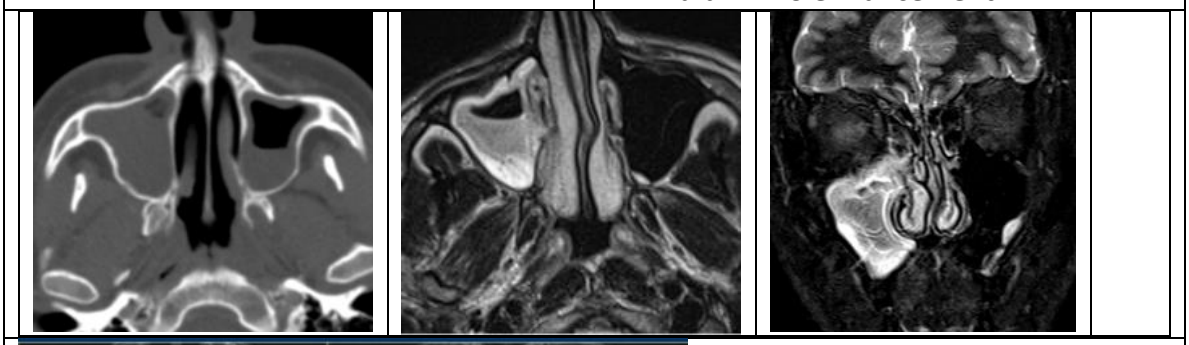
- **Mucosal thickening => Isointense**
- **Fluid => Hypointense**

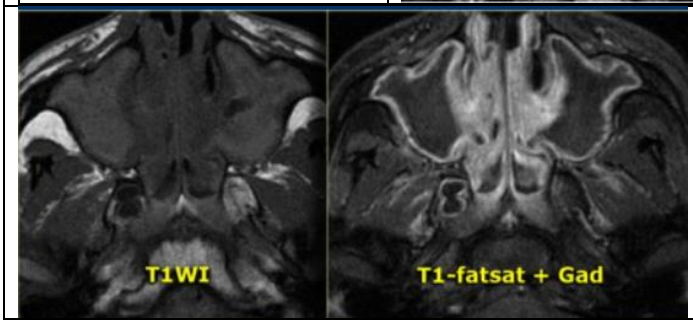
T2:

- **Mucosal thickening + Fluid => Hyperintense**

T1+C:

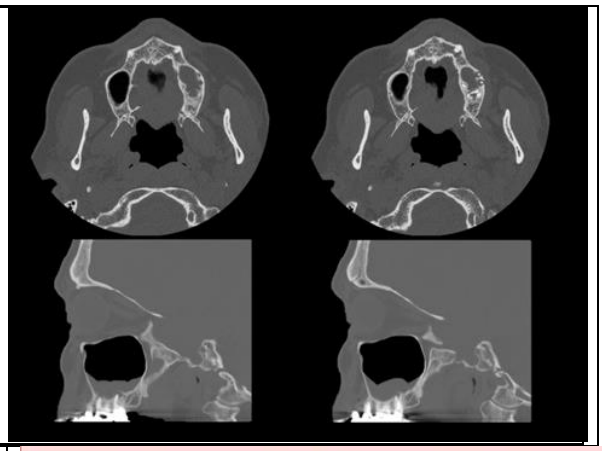
- **Mucosal thickening => enhance**
- **Fluid => No enhancement**





Odontogenic sinusitis

- Erosion of periapical granuloma or abscess into maxillary sinus
- Maxillary periapical tooth lucency with erosion into maxillary sinus
- Alveolar recess of maxillary sinus opacified
- Sinusitis manifestations
  - Mucosal thickening
  - Air-fluid level
  - Bubbly or frothy secretions
- Treatment
  - Primarily treat dental disease
  - Antibiotics



Complications of Acute Sinusitis

A. Orbital complications

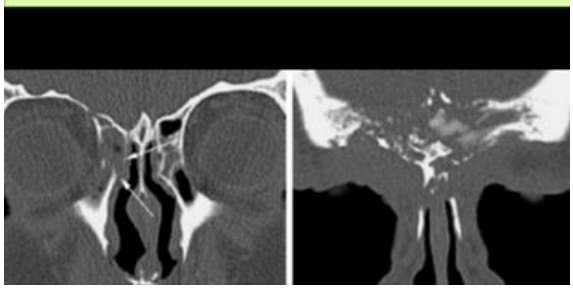
B. Intracranial complications

C. Superficial complications

A. Intracranial Complications

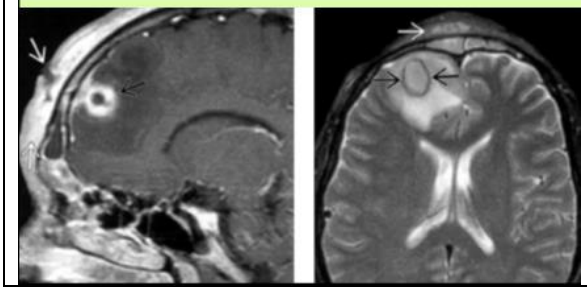
- Frontal bone Osteomyelitis
- Meningitis
- Empyema
  - Epidural abscess
  - Subdural abscess
- Focal Cerebritis +/- Cerebral Abscess
- Sinus Thrombosis

Frontal sinusitis => Frontal bone Osteomyelitis

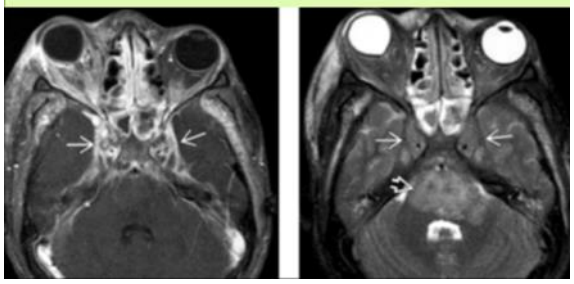


Epidural Abscess / Empyema + Potty's Puffy Tumor

Cerebral Abscess

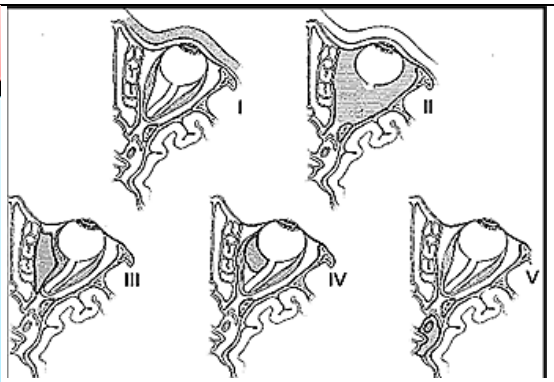


Cavernous sinus thrombosis:

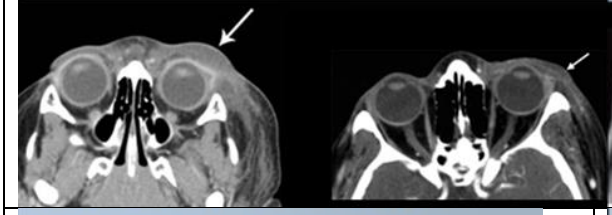


B. Orbital Complications

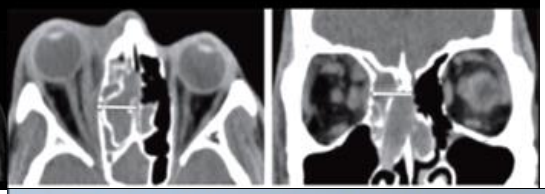
- Group I : Preseptal cellulitis = Periorbital cellulitis
- Group II : Postseptal cellulitis = Orbital cellulitis
- Group III : Subperiosteal abscess
- Group IV : Intraorbital abscess
- Group V : Cavernous sinus thrombosis.



PRESEPTAL CELLULITIS = (PERIORBITAL CELLULITIS)

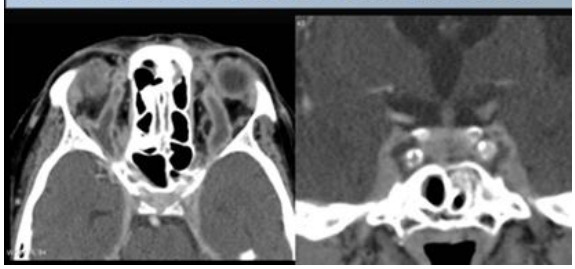


SUBPERIOSTEAL ABSCESS DUE TO ETHMOIDAL SINUSITIS



PERIORBITAL (ARROW HEAD) + ORBITAL (ARROWS) CELLULITIS

OPHTHALMIC VEIN THROMBOSIS CAVERNOUS SINUS THROMBOSIS



❖ Chronic Sinusitis

- **Opacification of the PNS with: mucosal thickening, polyps, fibrosis and retained secretion.**
- **Bony changes: Osteitis – Sclerosis – diminished volume of the sinus cavity.**

Severity of Sinonasal Diseases

3 point scale

0 = No opacification

1 = Partial opacification

2 = Total opacification

Patterns of Sinonasal Diseases:

A. Maxillary infundibular pattern

B. Frontal recess pattern

C. Ostiomeatal unit pattern

D. Sphenoethmoidal recess pattern

E. Sinonasal polyposis pattern.

F. Sporadic pattern.

A) Infundibular Pattern:

- The ethmoid infundibulum (dotted line) is obstructed by thickened mucosa
- The ethmoid infundibulum is markedly narrowed by :
  - ➢ **Large infraorbital ethmoid cell, Haller cell (H)**
  - ➢ **Concha bullosa (CB)**
  - ➢ **Uncinate process variants**

B) Ostiomeatal Complex Pattern:

- Obstruction of drainage systems in the middle meatus by mucosal thickening / nasal polyps

⇒ **Maxillary sinusitis**

⇒ **Frontal sinusitis**

⇒ **Anterior ethmoid sinusitis**

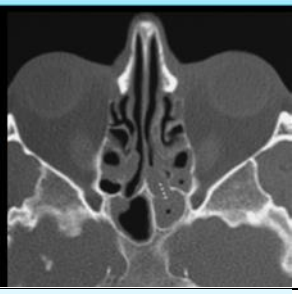
C) Sphenoethmoid Recess Pattern

Axial CT

- Obliteration of sphenoethmoid recess by mucosal thickenings

=> Sphenoid Sinusitis

⇒Posterior Ethmoiditis



D) Frontoethmoid Recess Pattern

- Obstruction of the frontoethmoidal recess with mucosal thickening / polyps

⇒**Frontal sinusitis**

⇒**+/- Anterior ethmoidal sinusitis**

E) Sinonasal Polyposis Pattern

- Bilateral filling of the ethmoid, nasal fossae middle meati, ethmoid infundibula and PNS by inflammatory polyps.
- Bone remodeling = Thinning + Displacement
- Widening of ethmoid infundibulum
- Truncation of middle turbinate

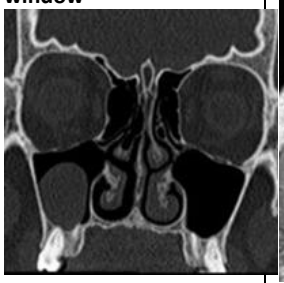
F) Sporadic Pattern

- Sporadic pattern includes a wide list of different conditions unrelated to impairment of any of drainage patterns such as:
  - –Isolated sinusitis
  - –Retention cyst
  - –Mucocele
  - –Post-surgical changes

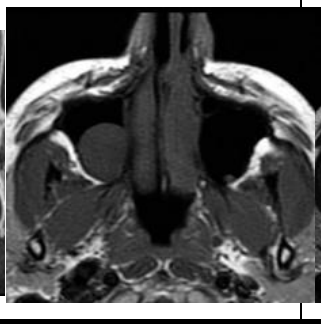
1) Mucus Retention Cyst

- Maxillaryt sinus most common.
- 2ry to obstruction of mucosal salivary glands.
- Well dfiend smooth convex borders.
- No complete opacification
- No sinus expansion
- No bone changes

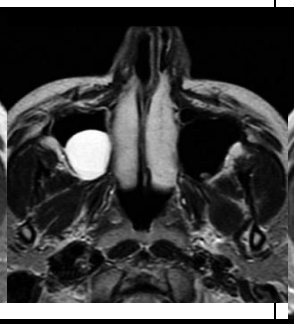
Coronal CT Bone window



Axial T1



Axial T2



Axial T1+C

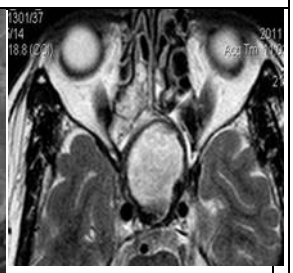
2) Mucocele

- Frontal & ethmoidal common
- Maxillary & sphenoidal rare
- Associated with chronic fungal sinusitis
- Complete opacification of sinus
- Expansion of sinus
- CT: Bone thinning + resorption
- T1
  - Water rich content: low signal (most common)
  - Protein rich content: high signal
- T2:
  - Water rich content: high signal (most common)

Protein rich content: low signal

Frontoethmoidal Mucocele

Sphenoidal Mucocele



Fungal Sinusitis

Invasive	Non invasive
•Acute	•Allergic
•Chronic	•Fungus ball (Mycetoma)
•Chronic granulomatous	

1) Acute Invasive Fungal Sinusitis

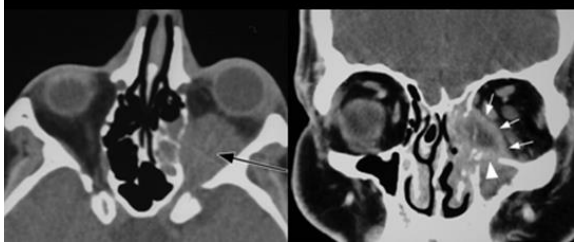
- The most lethal form of fungal sinusitis.
- Mucormycosis is one of the most aggressive types of fungal sinusitis.
- Mostly unilateral involvement of the ethmoid and sphenoid sinuses.
- These fungi tend to extend along the vessels, and extension beyond the sinuses may occur with intact bony walls.
- CT is better to assess for bone changes,
- MRI is superior in evaluating intracranial and intraorbital extension of the disease.

Radiological features

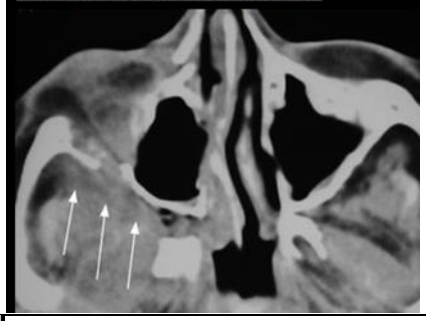
- **Non-contrast CT demonstrates**
  - Hypoattenuating mucosal thickening,
  - Bone erosion(may be very subtle)
  - Area of soft-tissue attenuation.
  - Obliteration of the periantral fat. (subtle sign)
- **Cavernous sinus infiltration:**
  - Thrombosis of the cavernous sinus
  - Pseudoaneurysm formation of ICA
  - Inflammatory vasculitis (Carotid arteritis)
  - Embolic phenomenon (bland or mycotic)
  - Thrombosis of ICA.

Right ethmoidal and sphenoidal sinusitis with right Cavernous sinus invasion

Left ethmoidal sinusitis with intra-orbital soft tissue mass



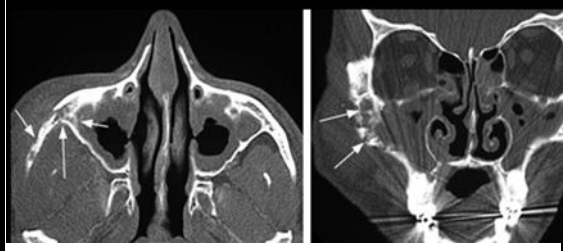
Obliteration of retro-antral fat sign



2) Chronic Invasive Fungal Sinusitis

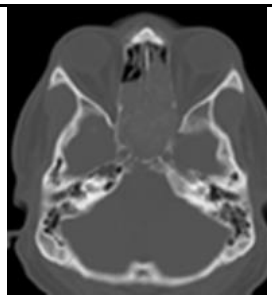
- Insidious progression occurs in which fungal organisms invade the mucosa, submucosa, blood vessels, and bony walls of the paranasal sinuses.
- **Non Contrast CT:**
  - A hyperattenuating soft-tissue collection is seen
  - May be masslike and mimic a malignancy
  - Mottled lucencies or irregular bone destruction may be seen
  - Sclerotic changes in the bony walls of the affected sinuses representing chronic sinus disease
- **MRI:**
  - Hypointense in T1WI
  - Marked hypointense in T2WI

Bone invasion in the form of mottled areas of low attenuation in the zygomatic process of the right maxillary bone



3) Chronic Granulomatous Invasive Fungal Sinusitis

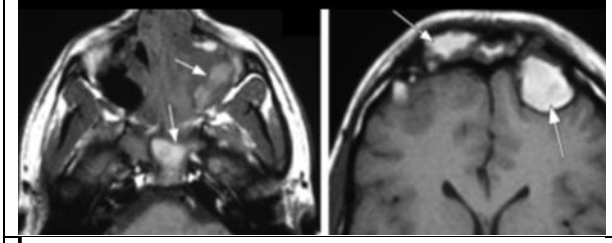
- Individuals are generally immunocompetent.
- The disease is characterized by noncaseating granulomas in the tissues.
- It follows a chronic indolent course with eventual extension beyond the walls of the paranasal sinuses with orbital and intracranial extension.
- Cross-sectional imaging findings are expected to be similar to those of chronic invasive fungal sinusitis



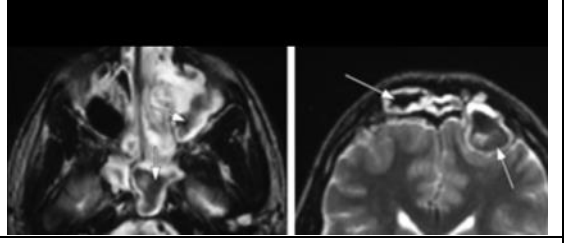
4) Allergic Fungal Sinusitis

- The most common form of fungal sinusitis.
- There is usually involvement of multiple sinuses.
- Tends to be Bilateral.
- Near-complete opacification of sinuses
- Expansion of sinuses.
- Non Contrast CT:
  - A hyperattenuating soft-tissue within the lumen
  - Bone expansion and remodelling.
- MRI:
  - T1: Hypointense, intermediate or hyperintense
  - T2: Marked hypointense or signal void
  - (iron, manganese, magnesium & protien content)

Characteristic hyperintense T1 signal



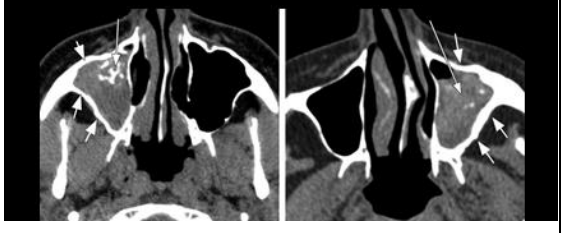
Characteristic hypointense T2 signal



5) Fungus Ball (Mycetoma)

- Relatively uncommon manifestation of fungal sinusitis.
- Maxillary sinus is the most involved sinus.
- Non Contrast CT:
  - A hyperattenuating mass within the lumen
  - Punctate calcifications may appear.
  - Inflamed mucosa is hypodense.
- MRI:
  - Hypointense in T1WI
  - Hypointense or signal void in T2WI
  - (iron, manganese, magnesium & calcifications)

Typical hyperattenuating fungus ball with calcific foci in the maxillary sinus



❖ Atrophic Rhinitis

- The disease is characterized by a sclerotic change in the mucous membrane and abnormal patency of the nasal passages due to atrophic changes in the mucosa and underlying bones

Classified into two types:

- Primary or idiopathic type
- Secondary type

- Young and middle aged adults
- F >>> M
- Lower socioeconomic classes with poor hygienic conditions

Risk factors for 1ry Atrophic Rhinitis:

- Autoimmune - Chronic sinus infection - Hormonal imbalance
- Poor nutritional status - Iron deficiency anemia.
- Chronic bacterial infection of the nose or sinus may be one of the causes of primary atrophic rhinitis: Klebsiella – Pseudomonas aeruginosa

Clinical picture:

- Nasal crust - Foul odour - Anosmia

Pace-Balzan et al. list characteristic Imaging Findings:

- Mucosal thickening of paranasal sinuses
- Hypoplasia of the maxillary sinuses
- Enlargement of the nasal cavities
- Resorption of the ethmoid bulla and uncinate process => Loss of definition of ostiomeatal complex
- Erosion and bowing of the lateral nasal wall
- Bony resorption and mucosal atrophy of the nasal turbinates

❖ Small Sinus:

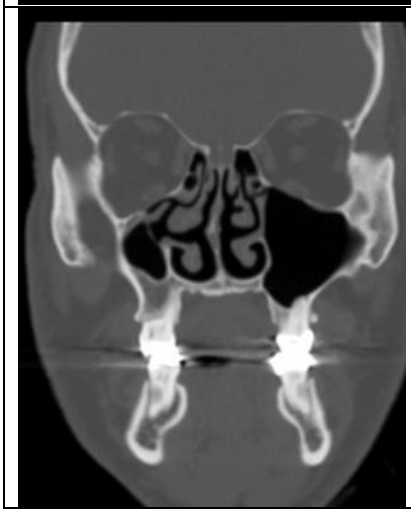
1. **Silent sinus syndrome**
2. **Congenital sinus hypoplasia**
3. **Post-surgery**
4. **Post-trauma**

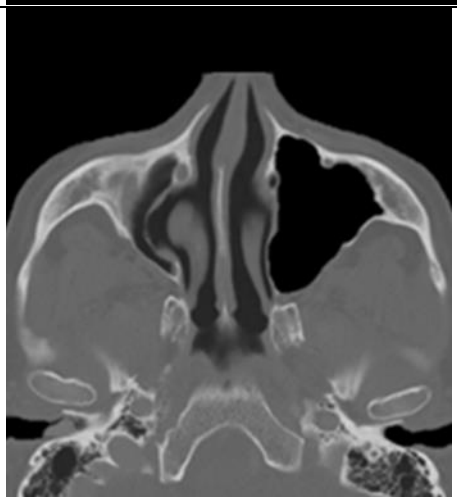
Silent Sinus Syndrome

- **Characterized by:**
  - **–Painless facial asymmetry**
  - **–Enophthalmos**
  - **–Atelectatic maxillary sinus.**

Radiological features

- Decrease in sinus volume
- Inward retraction of the sinus walls into the sinus lumen
- Lateral retraction of the uncinate process
- Expanded middle meatus
- Near or complete opacification of the sinus.
- In many cases the infundibulum is occluded.



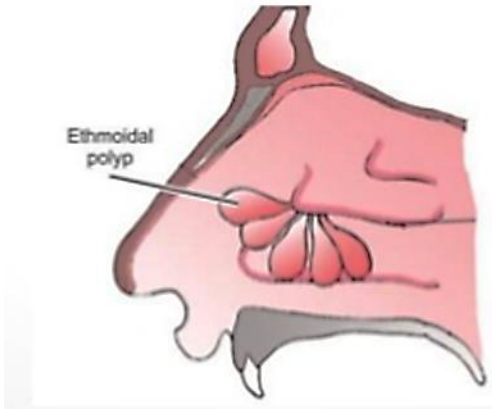


Nasal Polyps

Ethmoidal Polyps	Antrochonal / Sphenochonal Polyp
Adult	Children
Allergic	Infectious
Multiple	Single
Bilateral	Unilateral
Origin from ethmoidal air cells, uncinated process, middle meatus and middle turbinte	Origin from maxillary antrum => maxillary infundibulum
Grow anteriorly	Grow posteriorly
Punch of grapes	Trilobed: Antral, nasal, chonal parts

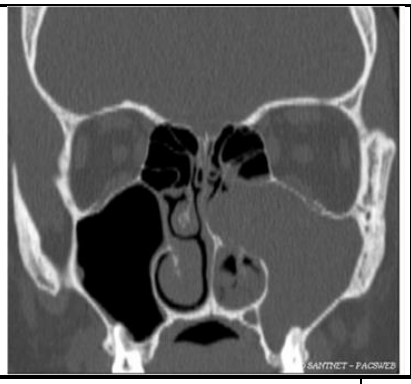
1) Ethmoidal Polyp:

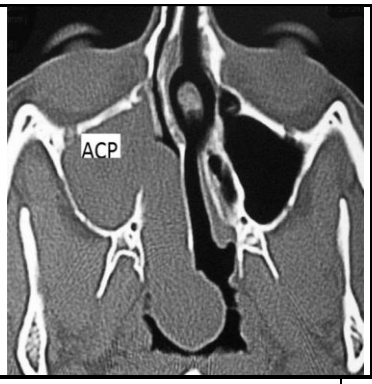
- Benign swelling of nasal mucosa of unkown cause.
- Arise from lateral nasal wall of the nasal cavity:
  - Ethmoidal air cells
  - Uncinated process
  - Bullo ethmoidalis
  - Middle meatus
  - Middle turbintae
- Associated with: Asthma – Aspirin sensitivity – Cystic fibrosis.
- Samter's triad: Nasal polypi + Asthma + Aspirin allergy



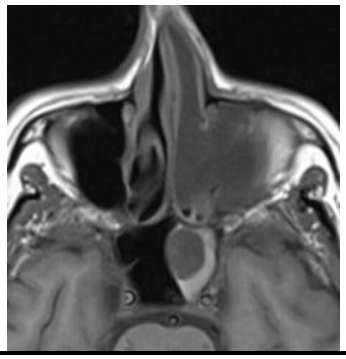
2) Antrochoanal polyp:

- Arise from maxillary antrum => Maxillary ostium => Ethmoidal infundibulum => Nasal cavity => Nasal Chona => Nasopharynx
- Bone widening and remodelling
- No bone destruction

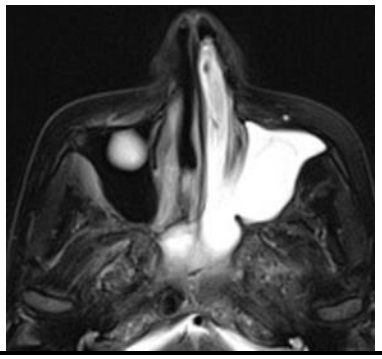




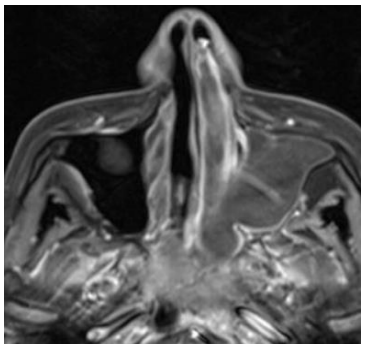
Axial T1



Axial T2 FS

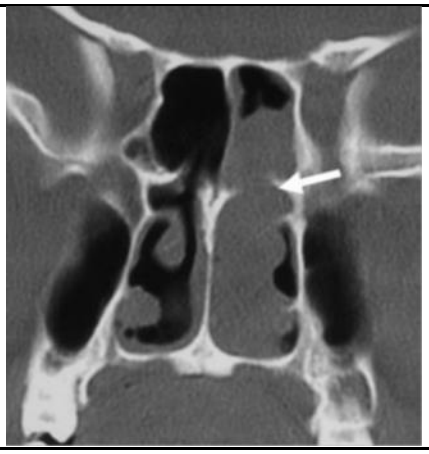


Axial T1+C FS



3) Sphenochoanal Polyp:

originating from the left sphenoid sinus ostium (arrow) extend to nasal cavity through sphenoethmoidal recess with its vertical orientation is diagnostic (arrow)



PNS BENIGN LESIONS

PNS Opacification + Bone Thinning + Bone Remodeling:	
1. Nasal Polyps: ○ Ethmoidal polyp ○ Antrochoanal polyp ○ Sphenochoanal polyp 2. Mucocele 3. Allergic fungal sinusitis	<u>Odontgenic cysts</u> <u>(Discussed with Mandible):</u> 4. Dentigerous cyst 5. Odontogenic keratocyst 6. Ameloblastoma

PNS DESTRUCTIVE LESIONS

PNS Opacification + Bone Destruction:
1. Inverted papilloma 2. Nasopharyngeal angiofibroma 3. Sinonasal malignant tumor • Carcinoma • Esthenioneuroblastoma • Lymphoma • Metastasis • Multiple myeloma / plasmacytoma • Melanoma • Rhabdomyosarcoma 4. Aggressive fungal infection.

1) Inverted Papilloma

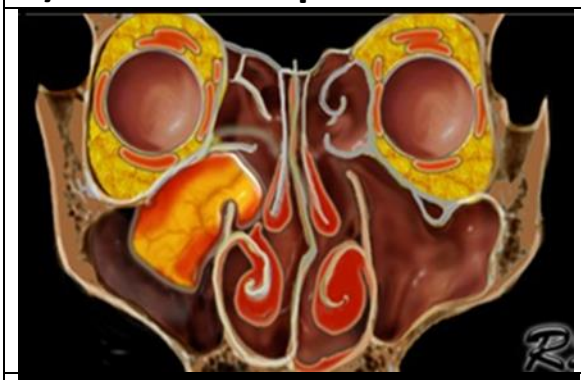
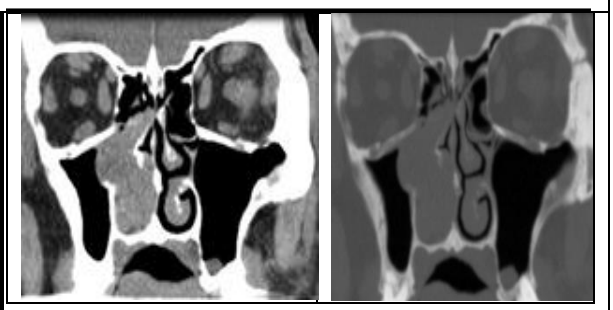


Table 8.2. Staging system for inverted papilloma (Han)

Group I	Tumor involvement limited to the nasal cavity, lateral nasal wall, medial maxillary sinus, ethmoid sinus, and sphenoid sinus
Group II	Same as group I except that tumor extends lateral to the medial maxillary wall
Group III	Tumor extends to involve the frontal sinus
Group IV	Tumor extends outside the sinonasal cavities (i.e., orbital or intracranial extension)

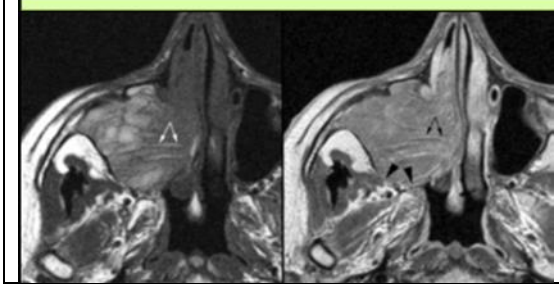
- Unilateral nasal Polypoidal lesion
- Arising from the lateral nasal wall
- Middle meatus and middle turbinate
- Spread early into the maxillary sinus via remodeling and destruction of its medial bony wall
- Lobulated contour
- Septate striated pattern or a convoluted cerebriform pattern
- T1: differentiate between hypointense signal of the tumor and hyperintense signal of retained secretions due to proteinaceous content.
- T2: parallel folds of inverted papilloma appear as thick striations of hyperintense signal alternate with thinner ones, closer to fat intensity.
- T1+C: stroma shows a strong enhancement while the thinner epithelium has a lesser enhancement

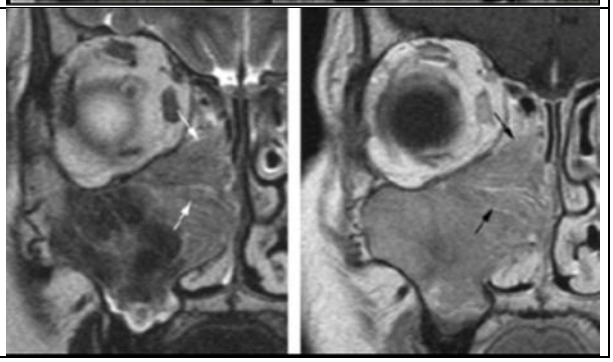


Lateral nasal wall polypoidal lesion
Middle meatus + Turbinate region
Maxillary sinus invasion
Bone remodeling and expansion

Lateral nasal wall polypoidal lesion (*)
Middle meatus + Turbinate region
Precontrast T1 hyperintense maxillary sinus retained secretions

Septate Striated Pattern





2) Juvenile Nasopharyngeal Angiofibroma:

Juvenile Nasopharyngeal Angiofibromas

- Locally aggressive vascular tumor
- Males teenage
- Unilateral epistaxis
- The lesion arise from the region of the sphenopalatine foramen

Radiological Features:

- Lobulated mass
- Centered on the sphenopalatine foramen (which is often widened)
- Typically bowing the posterior wall of the maxillary antrum anteriorly.
- Bone remodeling and resorption.
- T2: Salt and pepper appearance
- T1+C: Marked enhancement
- Prominent flow-voids

Pathways of spread:

→ **Medially => Sphenopalatine foramen => Nasal fossa + Nasopharynx**

→ **Laterally => Pterygopalatine fossa**

- ⇨ **Pterygomaxillary fissure => Masticator space.**
- ⇨ **Inferior orbital fissure => Orbital apex**

→ **Anteriorly => Anterior displacement of the posterolateral wall of the maxillary sinus = Holman-Miller sign**

→ **Cranially => Intracranial extension via:**

- ⇨ **Erosion of the sphenoid sinus floor => Sphenoid sinus**
- ⇨ **Foramen rotundum**
- ⇨ **Erosion of GWS**

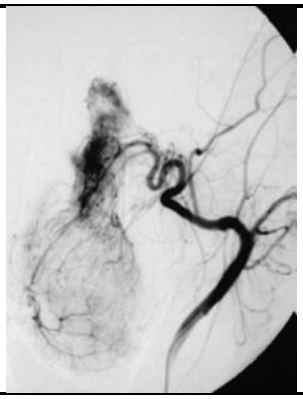
Chandler et al Staging:

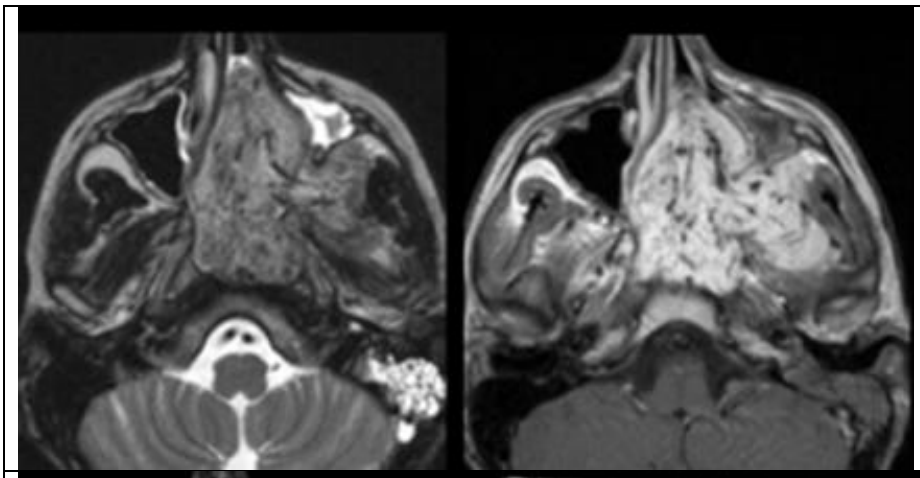
I - Tumor confined to nasopharyngeal vault.
II - Tumor extends into nasal cavity or sphenoid sinus
III - Tumor extends into antrum, ethmoid sinus, pterygomaxillary fissure, orbit, and/or cheek
IV - Intracranial tumor

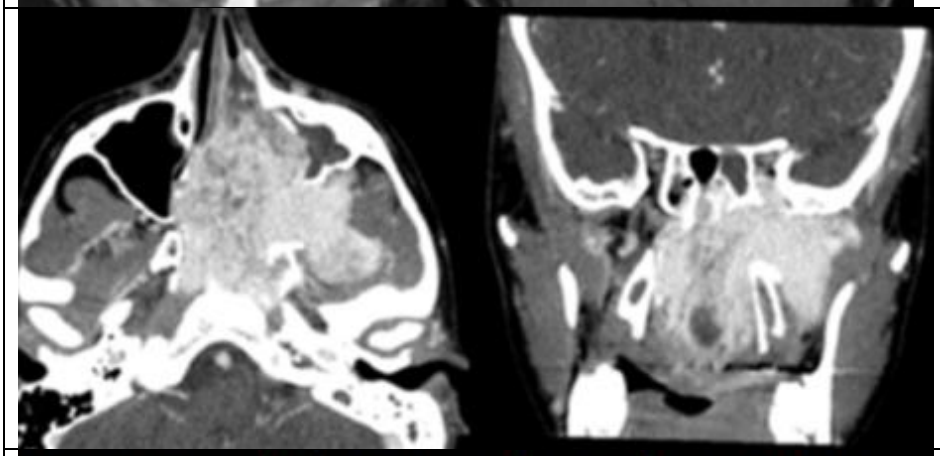
DSA:

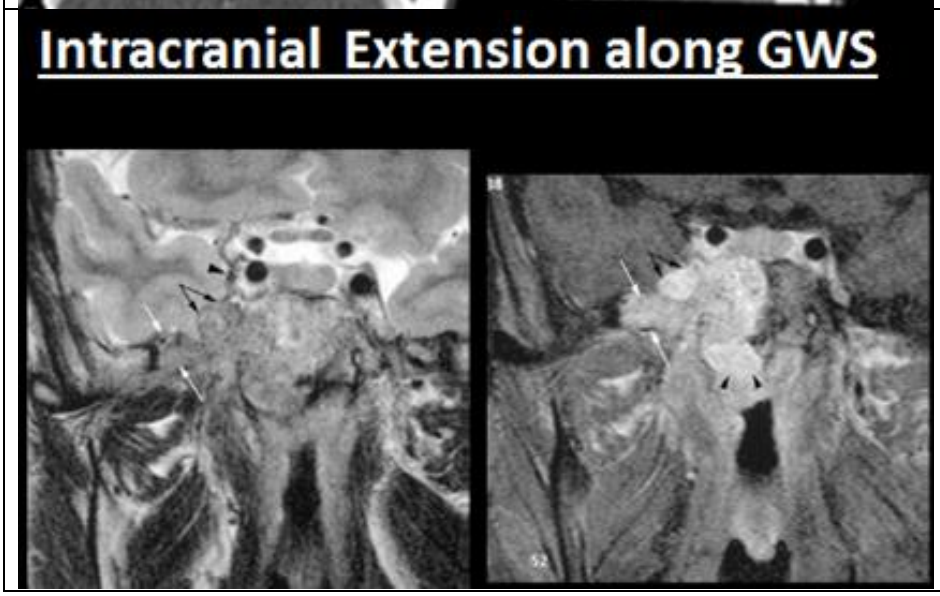
Vascular feeder arise from ECA (majority)

- ⇨ Internal maxillary
- ⇨ Ascending pharyngeal








Intracranial Extension along GWS

3) SINONASAL MALIGNANT NEOPLASM

General Incidence: < 1% of all malignant tumors
Geographical Incidence: Africa & Japan > US
Age: 50-70years
Sex: M>F = 2:1

RISK FACTORS:

- Woodworkers→ higher incidence to develop Adenocarcinoma
- Nickel→ higher incidence to develop SCCa

Pathology:

➢ **Epithelial tumors:**	➢ **Non-Epithelial tumors:**
❖ Squamous cell carcinoma ❖ Adenocarcinoma ❖ Adenoid cystic carcinoma ❖ Mucoepidermoid carcinoma ❖ Esthesioneuroblastoma ❖ Melanoma	❖ Mesenchymal tumors (Fibrosarcoma – Rhabdomyosarcoma – Chondrosarcoma – Osteosarcoma) ❖ Lymphoma ❖ Metastasis

Squamous Cell Carcinoma

- Most common >80%

Location:

- Maxillary sinus (80%)
- Naso-Ethmoidal (20%)
- Frontal/sphenoid (< 5%)

Adenocarcinoma

- 2nd most common malignant tumor.

Location:

- Ethmoid > Maxillary sinus

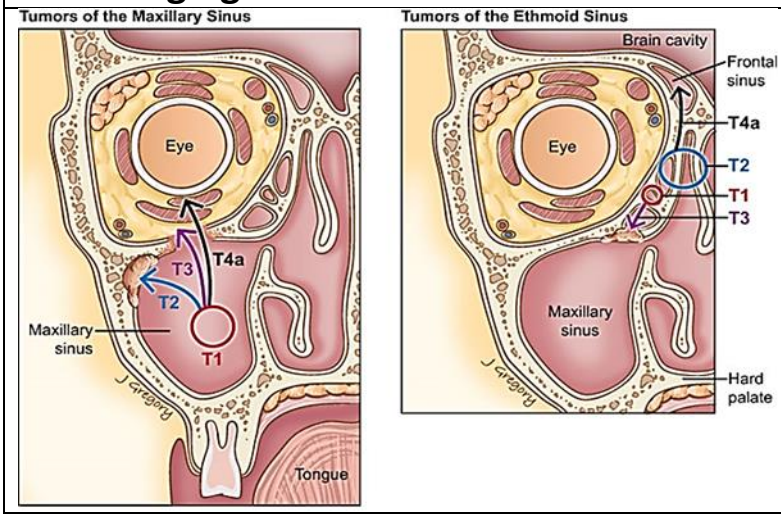
Site:

- **Naso-ethmoidal**
- **Maxillary sinus**

Radiological features:

- **CT:**
  - Soft tissue mass
  - Moderately enhancing (D.D.: Inflammation→ marked)
  - Local bone destruction (D.D.: Inflammation→ expansion)
  - Punctate intra-lesion calcification is occasionally seen.
- **MRI:**
  - T1→ Intermediate signal
  - T2→ Intermediate signal (DD: Inflammation ->high SI)
  - T1+C→ Moderate enhancement (DD: fluid within PNS => No enhancement)

TNM staging AJCC 7th Edition



T classification	Maxillary sinus	Nasal cavity and ethmoid sinus
Tis	Carcinoma in situ	Carcinoma in situ
T1	Tumour limited to the mucosal lining	Tumour limited to the mucosal lining at one subsite
T2	Bone erosion or destruction limited to the hard palate and middle meatus	Tumour at two subsites or adjacent nasoethmoid site
T3	Bone erosion or destruction of the posterior bone of maxillary sinus, floor and medial bone of orbit. Tumour growth into the pterygoid fossa or ethmoid sinus	Bone erosion of lamina papyracea or floor of orbit, maxillary sinus, palate and cribriform plate
T4a	Tumour growth into the anterior orbit, pterygoid plates, infratemporal fossa, cribriform plate, frontal sinus, sphenoid sinus, or skin of cheek	Tumour growth into the anterior orbit, anterior cranial fossa, pterygoid plates, frontal sinus, sphenoid sinus, or skin of nose or cheek
T4b	Tumour growth into the orbital apex, dura, brain, middle cranial fossa, cranial nerves other than V_2, nasopharynx and clivus	

N classification	Lymph node metastases
N0	No regional lymph node metastasis
N1	Metastasis in a single ipsilateral lymph node, 3 cm or less in greatest dimension
N2a	Metastasis in a single ipsilateral lymph node 3–6 cm
N2b	Metastases in multiple ipsilateral lymph nodes <6 cm
N2c	Metastasis in bilateral or contralateral lymph nodes <6 cm
N3	Metastasis in a lymph node >6 cm

❖ Tumor Spread & Extension:

Maxillary Sinus

Invasion of 5 bony walls:

- Medial wall => Intranasal extent
- Anterior wall => Pre-antral soft tissue
- Postero-lateral wall => Pterygo-palatine fossa + Masticator space
- Inferior (alveolar recess) => Hard palate
- Roof => Orbital extension

Naso-ethmoidal Neoplasm

- Nasal polypoidal mass.
- Naso-ethmoidal mass.
- Cranially => Fovea-ethmoidalis + cribriform plate => Anterior cranial fossa
- Laterally => lamina papyrecia => orbital extension
- Medially => nasal septum => Contralateral nasal fossa/ethmoid
- Anteriorly => Frontal sinus + Nasal bones
- Posteriorly => sphenoid sinus

Intracranial Extension

- Direct tumor extension or trans-foraminal or perineural spread
- Cortical destruction
- Medullary invasion
- Interruption of low signal periosteum interface
- Intra-cranial extra-dural extension
- Trans-dural invasion:
  - **Dural enhancement + focal nodularity**
  - **Dural thickening > 5mm**
  - **Pial enhancement**
- Brain parenchyma invasion + associated localized brain oedema.

Orbital Extension

- Through medial (Lamina paprecia) &/or lateral wall

1) Erosion of delicate bony orbital borders: detected on coronal CT
2) Displacement of extraconal fat without direct invasion: because of strong periorbita (orbital periosteum) acts as barrier to tumor spread.
3) Invasion of periorbita (orbital periosteum)
4) Infiltration of EOM: Enlargement / Abnormal SI / Enhancement of EOM
5) Infiltration of orbital fat.
6) Invasion of Nasolacrimal duct & sac.

Perineural Spread

- = Tumor extent along the peripheral nerve stroma (via endoneurium, perineurium, or perineural lymphatics).
- Centripetal direction = perineural spread towards the skull base foramina,
- Centrifugal direction = perineural spread can extend along the opposite direction.
- CT: widening/erosion of foramina/canals
- T1: replacement of the high fat signal with tumor intermediate signal
- T1+C FS: thickened + Enhancing nerve
- Chronic atrophy of masticator, mouth floor muscles.
- Tumoral lesions at some distance from 1ry site, in neural crossroad (e.g.: Pterygopalatine fossa & Meckel's cave)

Cavernous Sinus Invasion

- Enlargement and lateral bulging of the cavernous sinus
- T2: Replacement of the hyperintense venous signal by the intermediate tumor tissue
- Neoplastic encasement of ICA at the cavernous sinus
- Reliable signs of vessel infiltration:
  - – Enhancement of the thickened vessel wall
  - – Encasement of ICA > 2/3 of its circumference

Pterygopalatine Fossa Invasion

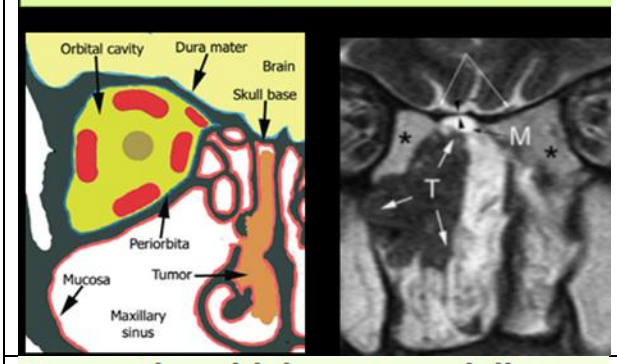
- Fat tissue surrounding the vessel is replaced by soft tissue density/intensity
- The maxillary vessel is encased or not recognizable
- The pterygoid process: cortical destruction, intra-medullary growth, and permeative invasion

Lacrimal pathway Involvement

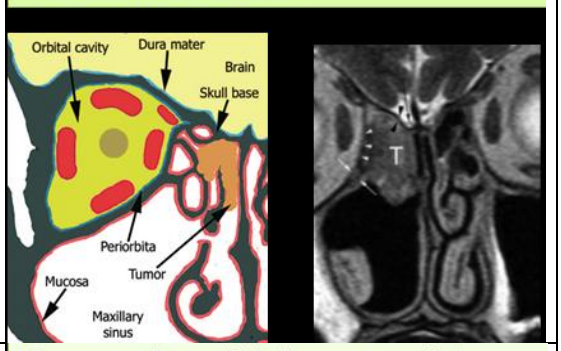
- Dilation of the lacrimal sac
- Lacrimal bone and/or nasolacrimal duct walls erosion
- Abnormal signal within the duct replacing its normal mucosa.

A- Naso-ethmoidal Tumors

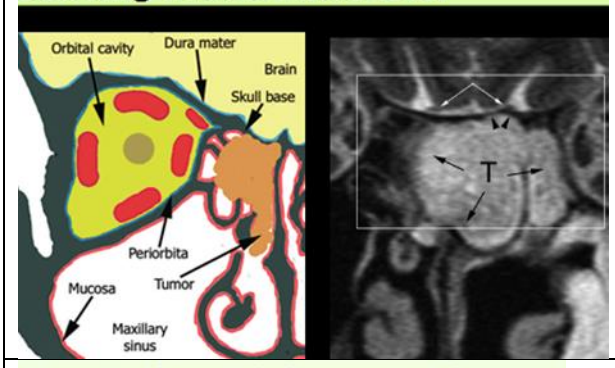
Naso-ethmoidal mass Non-contacting the ethmoid roof



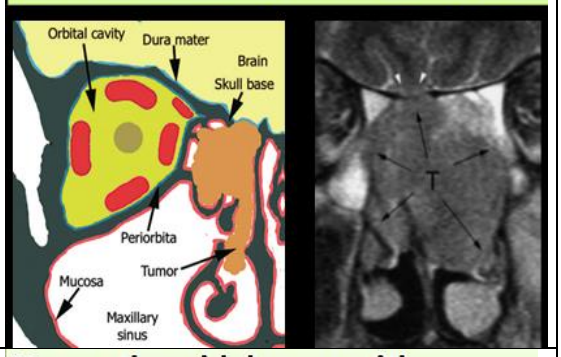
Naso-ethmoidal mass abutting the ethmoid roof



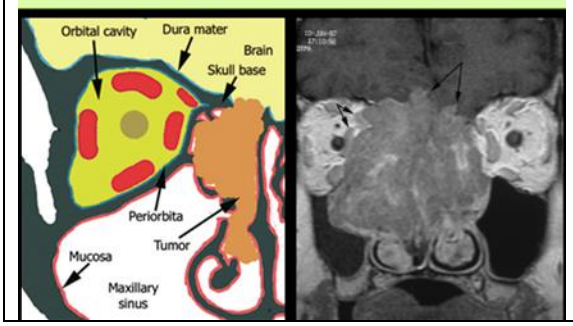
Naso-ethmoidal mass partially eroding the ethmoid roof



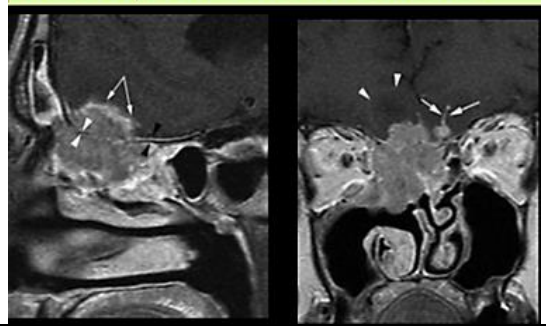
Naso-ethmoidal mass with intracranial extradural extent



Naso-ethmoidal mass with intracranial intradural extent



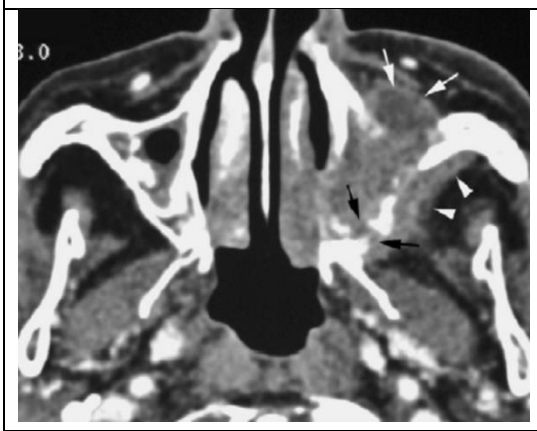
Naso-ethmoidal mass with olfactory lobe cerebral invasion

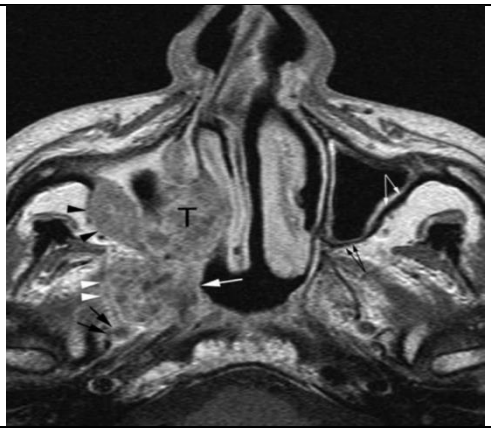


B- Maxillary Tumors

Axial Images:

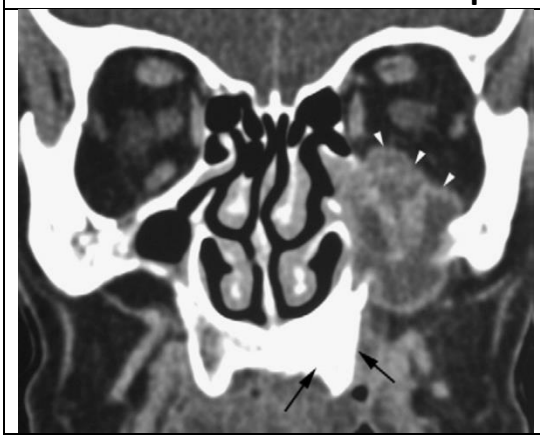
- **Anterior wall destruction => Pre-antral fat invasion.**
- **Posterolateral wall destruction => Retro-antral fat invasion => Massticator space invasion**
- **Posterior destruction => Pterygo-palatine fossa + Pterygoid plate invasion.**
- **Medial wall destruction => Intra-nasal extension**





Coronal Images:

- **Roof destrcution => Intra-orbital extension**
- **Floor destruction => Hard palate invasion**



C- Esthesioneuroblastoma

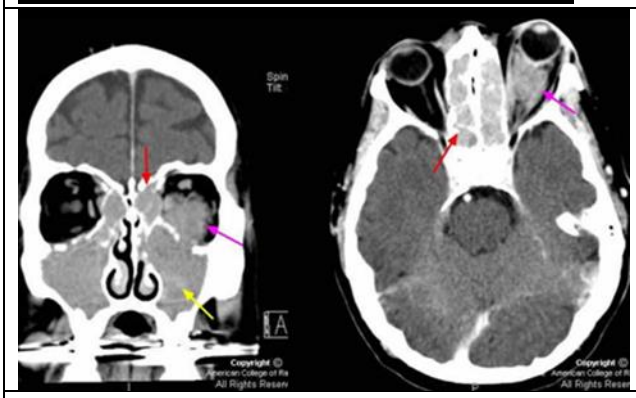
- Neuroendocrine malignancy of neural crest origin that arises from olfactory epithelium of superior nasal cavity.
- Bimodal: 2nd and 6th decades.
- Dumbbell mass with upper portion in intracranial fossa & lower portion in upper nasal cavity "waist" at level of cribriform plate

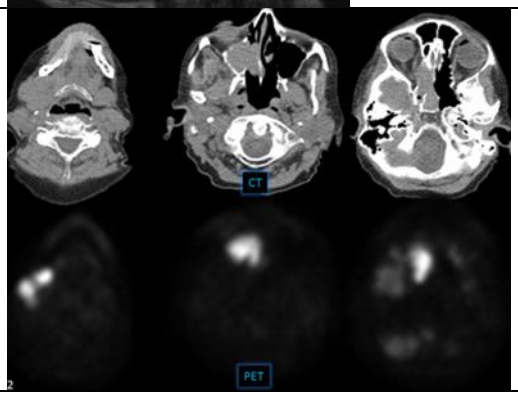
- Kadish classification
  - Group A: Involves nasal cavity, > 90% survive at 3 years
  - Group B: Involves nasal cavity and sinuses, > 80% survive at 3 years
  - Group C: Involves nasal cavity and intracranium, orbits, or lymph nodes, < 50% survive at 3 years

D- PNS Lymphoma

- 60% of lymphomas have an extranodal origin.
- 1ry >>>> 2ry
- NHL >>>> HD
- Nasal cavity > Maxillary sinus > Ethmoid sinus > Frontal sinus
- ill-defined diffusely infiltrating soft tissue mass
- T1: Intermediate signal
- T2: Hyperintense signal
- +C: Homogenous enhancement
- DWI: Restricted
- ADC: Low

PNS + Nasopharyngeal mass
Clival + calvarial invasion

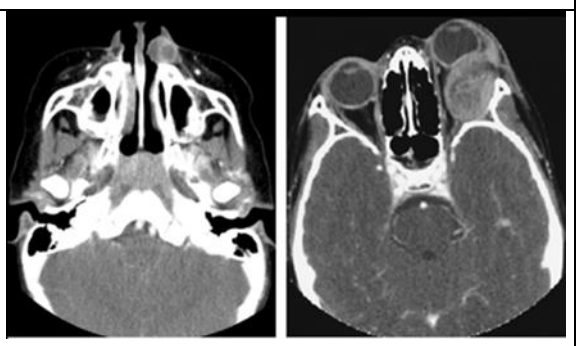


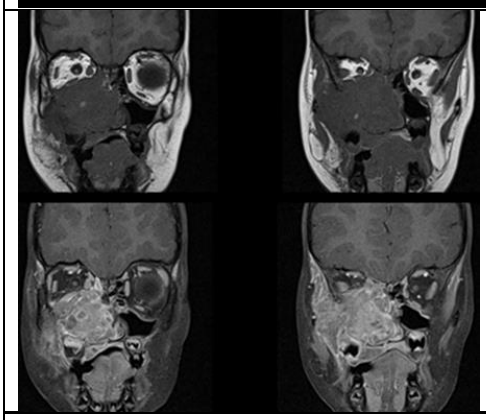


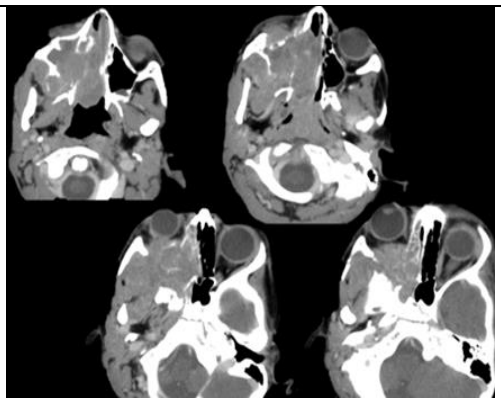
E- Naso-Orbital RMS

Naso-Orbital RMS

- Most common childhood sarcoma
- 40% in H&N
- Bimodal age
- 3 histological subtypes: Embryonal, alveolar, and pleomorphic
- Aggressive heterogeneous enhancing tumor
- Bone erosion and destruction

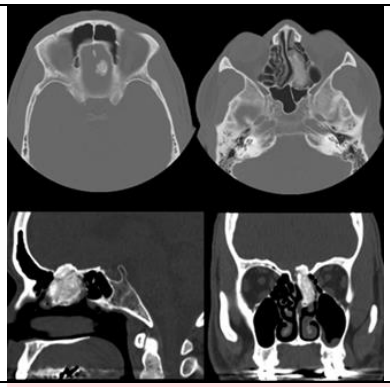




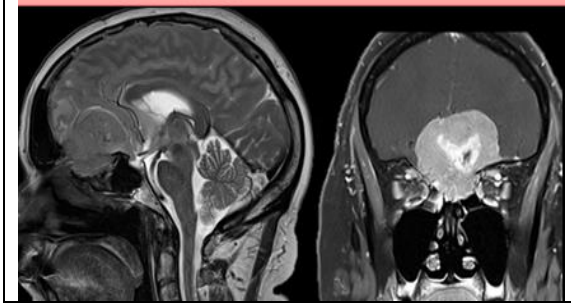


F- Sinonasal Meningioma

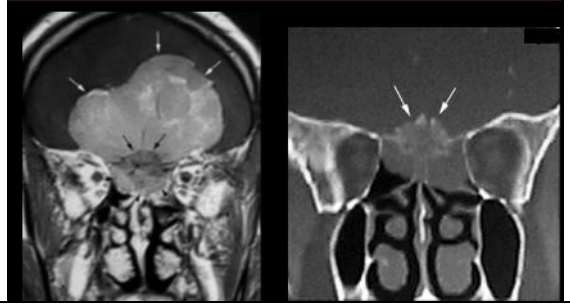
- Rare location for meningioma
- Most often arises intracranially with extension into nasal cavity
  - Less often arises from mengingothelial rests within sinonasal cavity
- Imaging features
  - Avidly enhancing mass
  - May contain calcifications
  - Associated hyperostosis may be present



Olfactory Groove Meningioma



Planum Sphenoidale Meningioma



PNS BONY LESIONS

Sclerotic	Lytic destructive	Mixed lytic and sclerotic
• Osteoma • Osteochondroma Ossifying fibroma • Fibrous dysplasia • Meningioma en-plaqueOsteosarcoma • Hemangioma • Sclerotic Metastasis	• Sinonasal tumors • Bone tumors • Metastasis	• Odontogenic osteomyelitis • Radiation osteonecrosis

Bone Tumors

Chondrosarcomas

- are malignant tumors of cartilaginous origin.

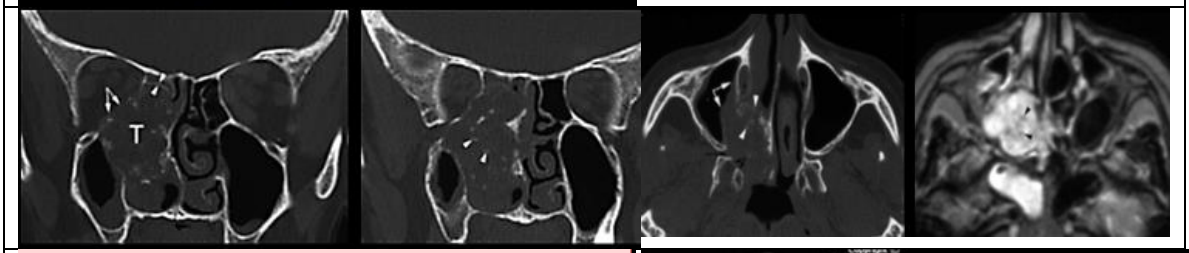
3 histological grades:

- Grade 1: well differentiated
- Grade 2: intermediate differentiated
- Grade 3: poorly differentiated

3 types:

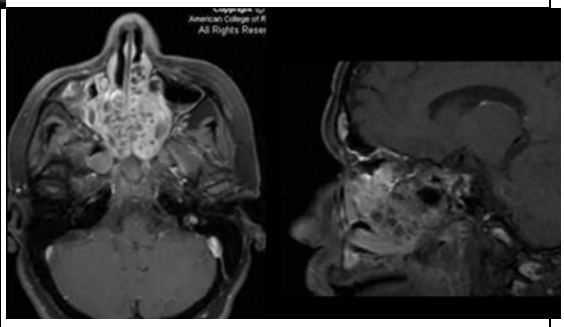
- Primary (originating from undifferentiated perichondrial cells),
- Secondary (taking origin from altered cells of a chondroma or cartilaginous exostosis),
- Mesenchymal (stemming from primitive mesenchymal cells)

- NCCT: Arc- or ring-like, stippled and dense calcifications
- T2: Chondroid matrix is hyperintense because of high water content.
- T1+C: Heterogeneous enhancement

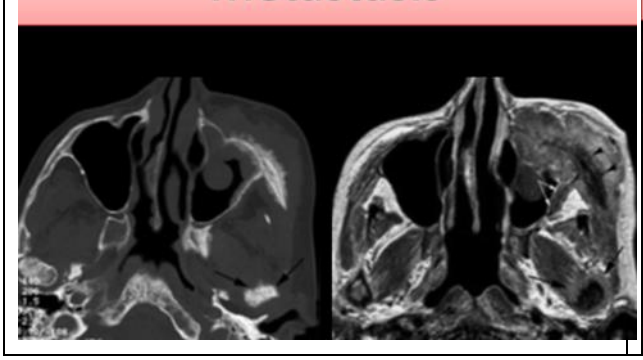


Sinonasal Hemangiopericytoma

- Hemangiopericytomas are rare soft-tissue tumors originating from extravascular cells (pericytes).
- They can arise from any part of the body but occur most frequently in the skeletal muscles.
- 15 to 30% of all hemangiopericytomas occur in the head and neck
- 5% occur in the sinonasal area.



Metastasis



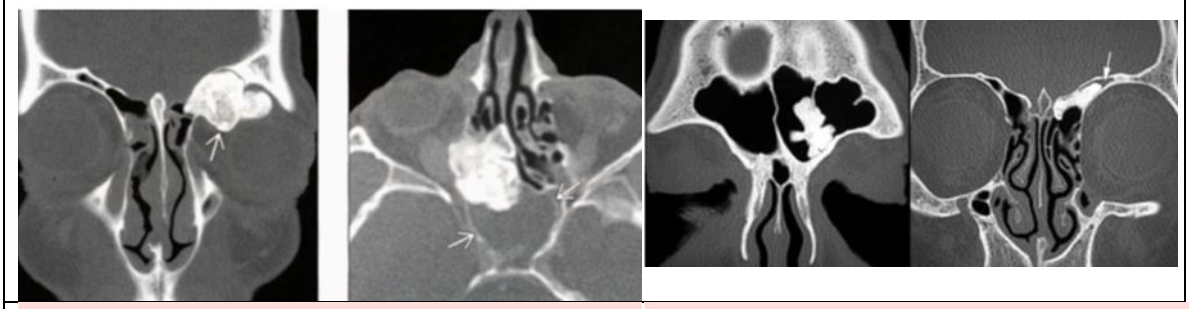
Ewing's Sarcoma

- A tumor arising within bone marrow.
- Primitive neuroectodermal tumors (PNET):
  - **Central PNET = Medulloblastoma**
  - **Peripheral PNET = Ewing sarcoma:**
    - **Skeletal subtype**
    - **Extra-skeletal subtype**
- Age: Children and young adults

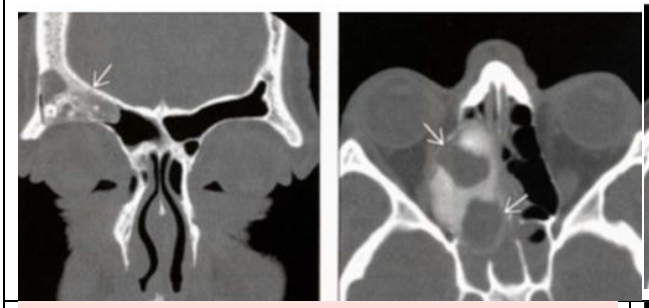
PNS Sclerotic Bony Lesions

Osteoma Osteochondroma Rhinolithiasis	Ossifying fibroma Fibrous dysplasia Meningioma en-plaque	Osteosarcoma Hemangioma Sclerotic Metastasis

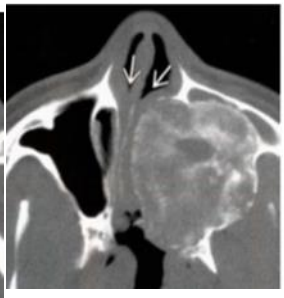
Fronto-ethmoidal Osteoma



Fronto-ethmoidal Ossifying Fibroma

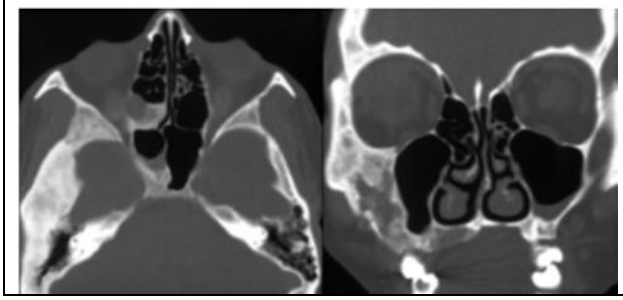


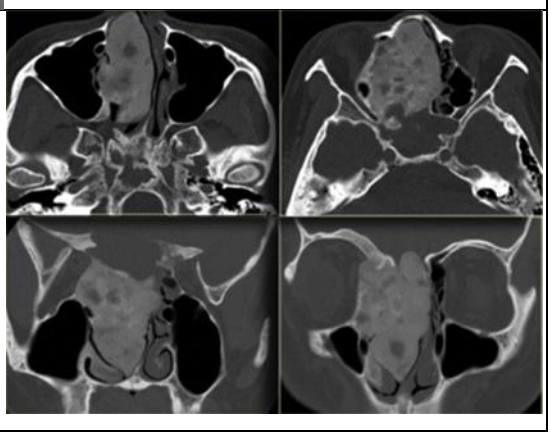
Maxillary Ossifying Fibroma



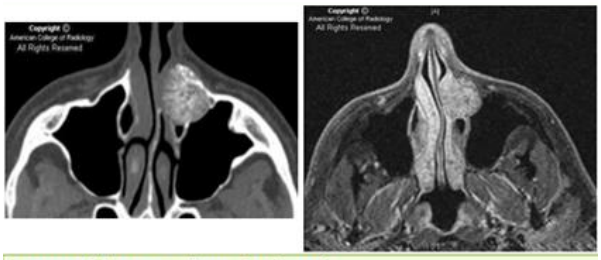
- Ossifying fibromas are well-circumscribed, expansile, benign mixed soft tissue and bone density lesions.

Fibrous Dysplasia





Cavernous Hemangiomas



Internal bony trabeculations in "honeycomb," "sunburst," or "spokewheel" pattern

Osteosarcoma

- Most non radiation-induced osteosarcomas of the sinonasal tract arise from the inferior aspect of the maxilla.
- NCCT:
  - Tumor matrix mineralization and osteoid matrix calcification.
  - Periosteal reaction => typical sunburst appearance
- MRI
  - Demonstrating the intramedullary and extra osseous tumor components

Rhinolithiasis

Nasal Septum

❖ Nasal Septum Perforation:

- **Trauma**
- **Surgery**
- **Infection: TB – Syphilis – Leprosy**
- **Lymphoma**
- **Wegener granulomatosis**
- **Sarcoidosis**
- **Cocaine abuse most commonly**

❖ Nasal Septum Destruction:

- **Carcinoma**
- **Esthesioneuroblastoma**
- **Lymphoma**
- **Leukemia / Chloroma**
- **Melanoma**
- **Metastasis**
- **Multiple myeloma / Plasmacytoma**
- **Malignant fibrous histiocytoma**
- **Various sarcomas**
- **Aggressive fungal infections**

1) Wegener Granulomatosis:

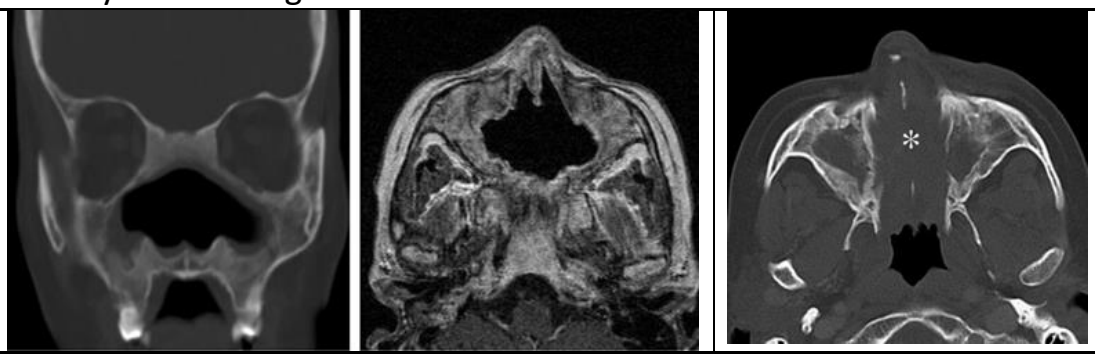
- Granulomatosis with polyangiitis = Wegener granulomatosis,
- Multisystem systemic necrotising non-caseating granulomatous vasculitis affecting small to medium sized arteries

The classic triad of organ involvement consists of:

- Lungs: 95%
- Upper respiratory tract / PNS: 75-90%
- kidneys: 80%

PNS manifestations:

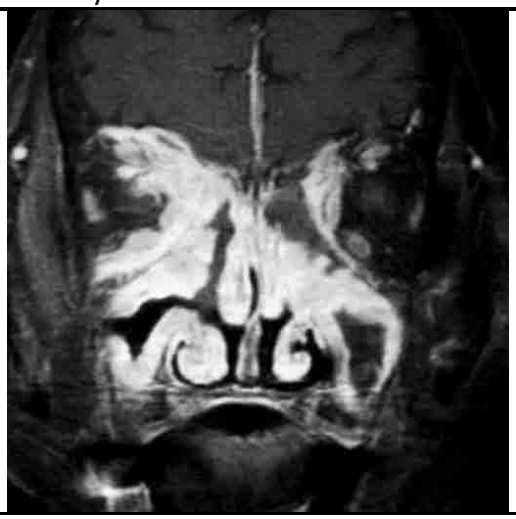
- Mucosal ulceration
- Granulomatous masses within the nasal cavities
- Bony and cartilaginous destruction



2) Lymphoma

Patterns of PNS involvement:

- ❖ Diffusely infiltrating lesions extending along walls of PNS and nasal cavity
- ❖ Discrete sinonasal soft tissue mass like lesions
- ❖ Bony destruction

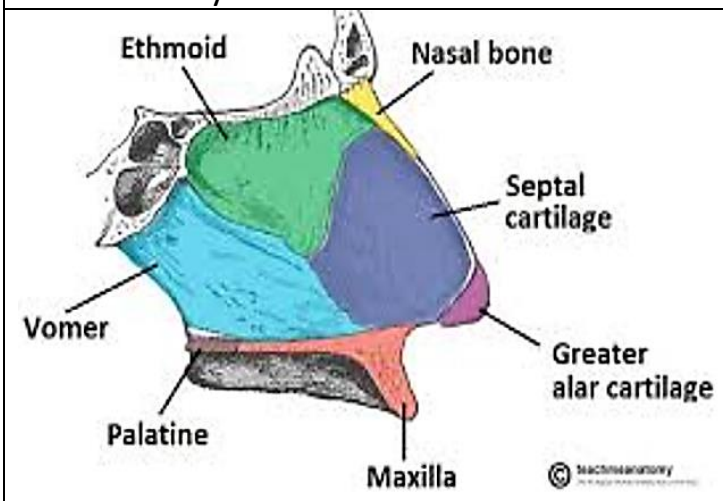


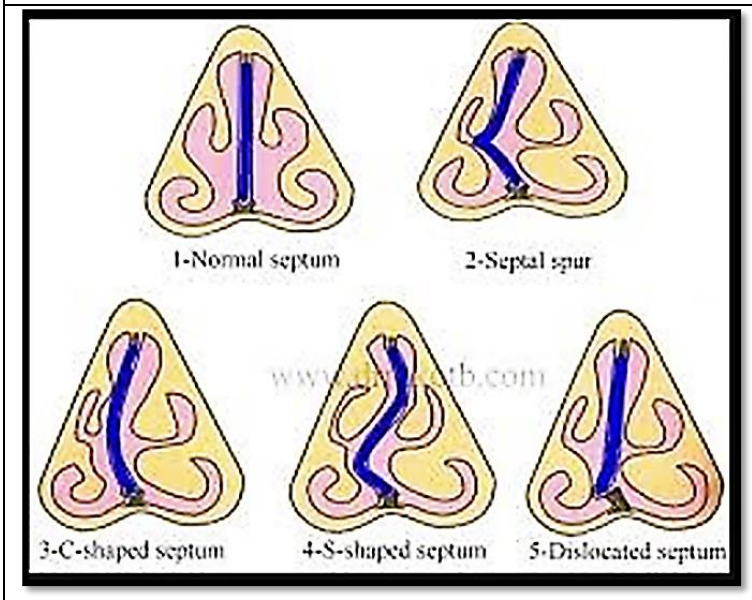
❖ Nasal Septum Deviation

- is a common incidental finding

- can be congenital or acquired.
- The most common acquired cause is trauma from motor vehicle accidents, sports-related injuries, and altercations

- commonly associated with concha bullosa





❖ Nasal Cavity Obstruction:

- **Choanal atresia**
- **Pyriform aperture stenosis**

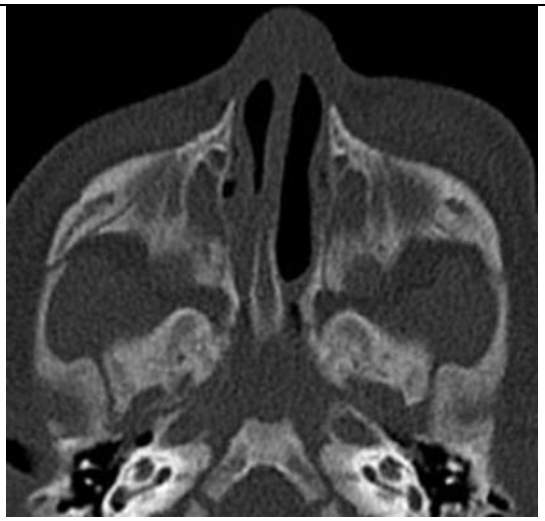
1) Choanal Atresia

- One of the commonest causes of nasal obstruction in neonates.

Associations

- CHARGE syndrome
- Crouzon syndrome
- DiGeorge syndrome
- amniotic band syndrome
- Fetal alcohol syndrome
- Treacher Collins syndrome

- Unilateral or Bilateral
- Osseous: ~90% or Membraneous: ~10%
- Posterior nasal airway narrowing <3 mm (measurement done at the reference level of the pterygoid plates in the axial plane)
- Air/fluid level may be present above obstruction.
- Thickening of the vomer
- Medial bowing of posterior maxillary sinus

Bilatreal Osseous	Bilateral Membranous
	

2) Pyriform Aperture Stenosis

- Rare cause of airway obstruction

Associations

- Alobar and semilobar forms of holoprosencephaly
- Facial hemangiomas
- Clinodactyly
- Pituitary dysfunction
- Central megaincisor (in 75% of cases)

Imaging Findings:

- A shelf of tissue extending across the nostrils just inside the nares
- Inward bowing of the maxillary spines
- Narrowing of the pyriform aperture results from early fusion and hypertrophy of the medial nasal processes

❖ Nasal Cavity Lesions:

- **Congenital:**
  - **Encephalocele**
  - **Nasal glioma**
  - **Nasal dermoid**
- **Middle turbinate abnormalities:**
  - **Concha bullosa**
  - **Paradoxical turbinate**
  - **Turbinate hypertrophy**
- **Nasal septum:**
  - **Deviation**
  - **Perforation / Destruction**
- **Nasal polyp:**
  - **Ethmoidal / nasal polyps**
  - **Antrochoanal polyp**
  - **Sphenochoanal polyp**
- **Rhinolithiasis**
- **Nasal tumor (Discussed before)**

❖Congenital Midline Nasal Masses

1) **Nasal Glioma**
2) **Encephalocele**
3) **Nasal Dermoid**

1) Nasal Glioma

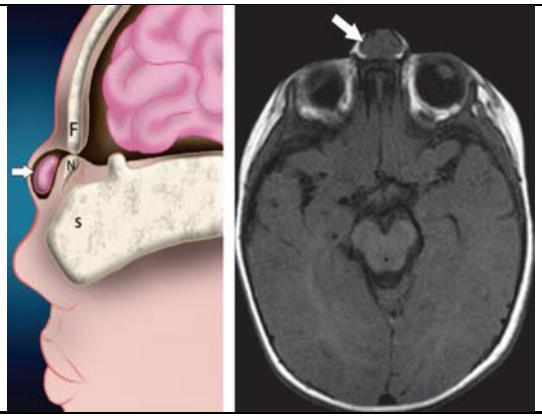
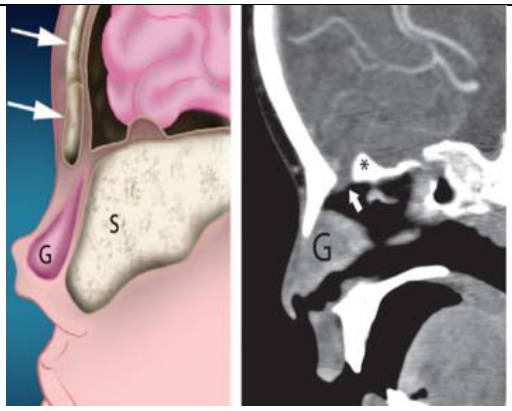
Rare, developmental mass of dysplastic neurogenic tissue sequestered & isolated from subarachnoid space.

Location:

i. Extranasal glioma(60%): mass along nasal dorsum.
ii. Intranasal glioma(30%): nasal cavity mass
iii. Mixed extra-intranasal (10%)

Radiological Features:

Well-circumscribed soft tissue attenuation mass (isodense to brain)
NO intracranial connection
IV Contrast: NO enhancement.
Intrathecal contrast: NO connection of lesion to subarachnoid space
CT Bone: Defect in cribriform plate (10-30%)
Sagittal T2: show pedicle of fibrous tissue (not brain parenchyma) between glioma & intracranial cavity

Extranasal Glioma:	Intranasal Glioma:
	

2) FRONTOETHMOIDAL CEPHALOCELE

Congenital herniation of meninges + CSF ± brain tissue through a defect in anterior skull base presenting as extranasal or intranasal mass

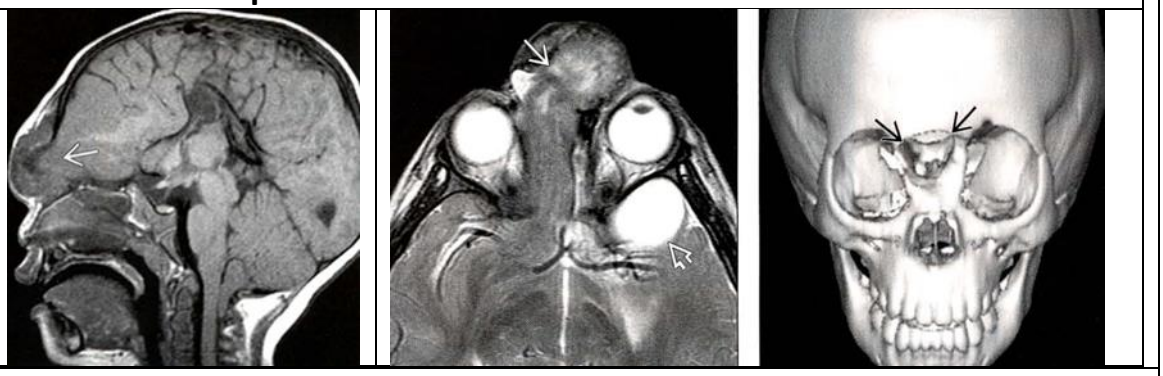
Location/3 Subtypes:

i. Frontonasal Cephalocele: Anterior forehead at glabella-dorsum of nose
ii. Nasoethmoidal Cephalocele : Superomedial nasal cavity
iii. Nasoorbital Cephalocele

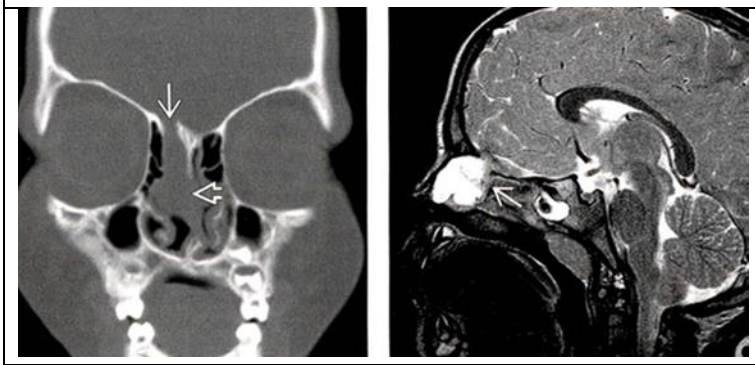
Radiological Features:

Frontal, nasal or medial orbital soft tissue mass contiguous with intracranial brain parenchyma extending through bony defect
Yes intracranial connection
Intrathecal contrast: Fills subarachnoid space & extending through bony defect
CT Bone: Deficient or absent cribriform plate, frontal bone, lacrimal bone
Sagittal T2: optimal for visualizing parenchyma through defect

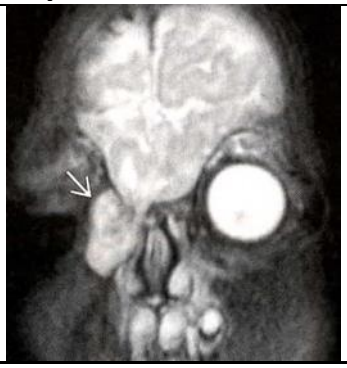
Fronto-nasal Cephalocele



Naso-ethmoidal Cephalocele



Naso-orbital Cephalocele



3) NASAL DERMOID / EPIDERMOID

Defective embryogenesis of anterior neuropore resulting in any mixture of dermoid, epidermoid ± sinus tract in frontonasal region.

Location: Epidermoid or dermoid seen from nose tip to apex of crista galli

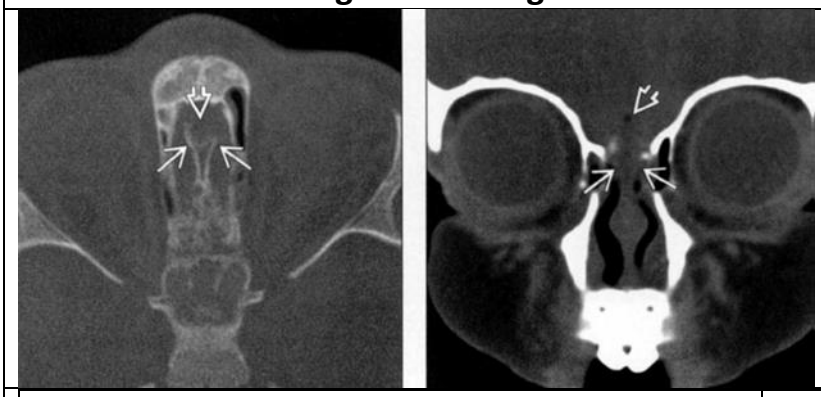
Radiological features:

Sagittal T1: Focal low signal (epidermoid) or high signal (dermoid) mass found between tip of nose & apex of crista galli

Fluid intensity mass = Epidermoid

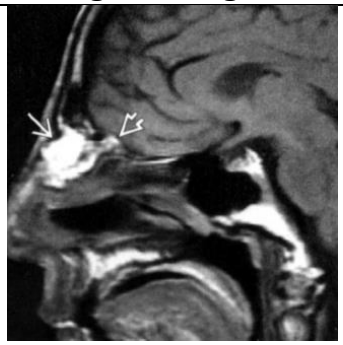
Fat intensity mass = Dermoid

Bone CT: Bifid crista galli with large foramen cecum

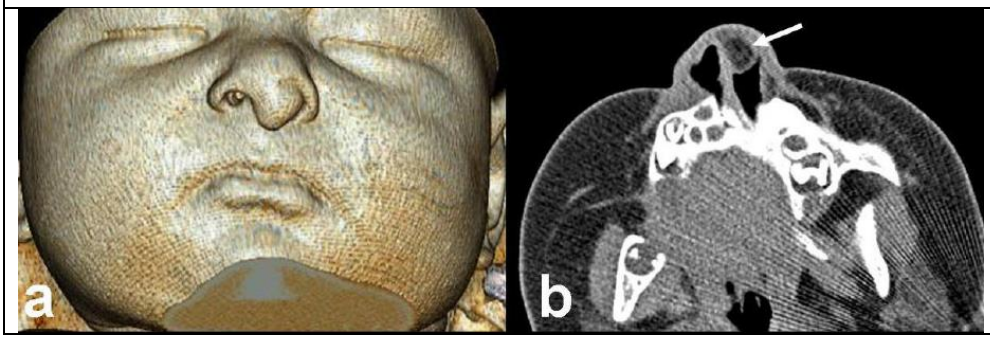


Nasal Epidermoid:
Low T1 + High T2 + Restricted DWI

Nasal Dermoid sinus =
Fat signal = High T1 & T2



Nasal Dermoid

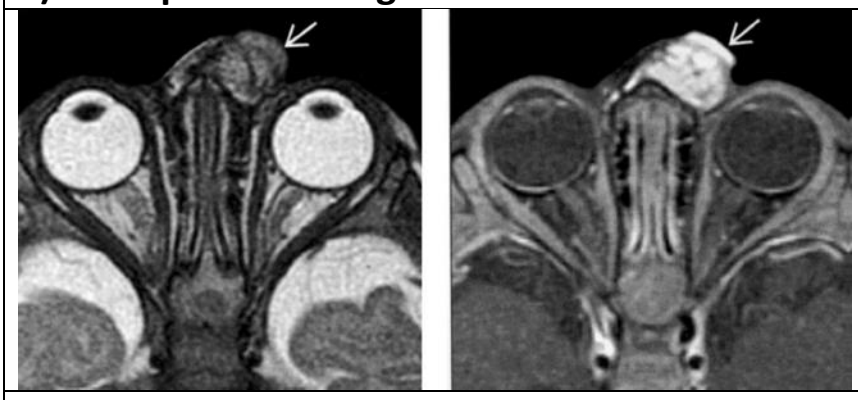


❖ Naso-Orbital Lesions

1) Naso-Orbital Dermoid / Epidermoid

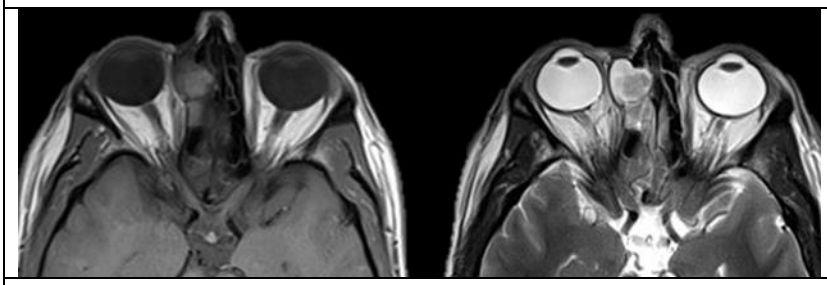
Well defined lesion.
No bone destruction
No deep invasion
No enhancement
Dermoid = Fat signal / Density
Epidermoid = Fluid signal / density

2) Preseptal Heamnigioma



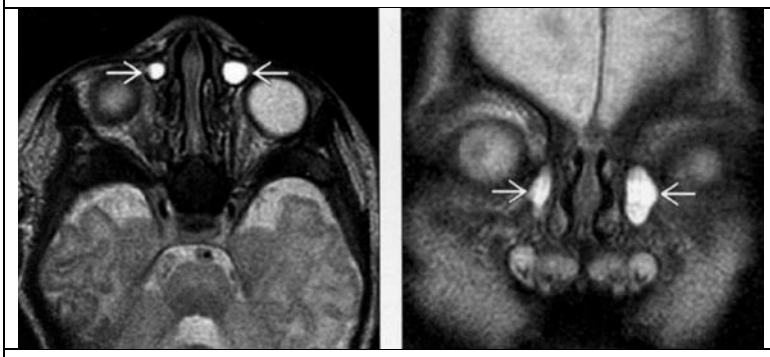
3) Ethmoidal Mucocele

Well defined expansile lesion
Bone thinning & remodeling
T1: High signal (due to high proteinaceous content)
T2: High signal
+C: No enhancement



4) NASOLACRIMAL DUCT DACROCYSTOCELE

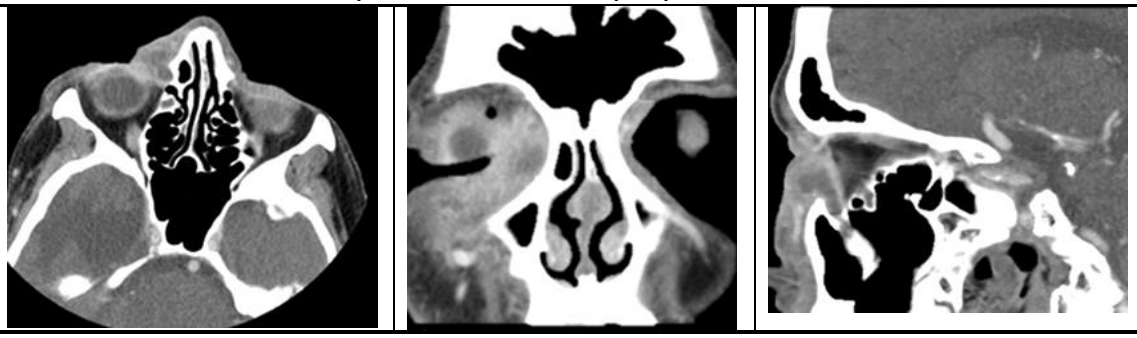
Cystic dilatation Nasolacrimal apparatus secondary to proximal ± distal obstruction of NLD



5) Dacrocystitis

Inflammation of the lacromal sac and lacrimal duct

Most common case: Staph. aureus – Strept. pneumonia



6) Dacryolithiasis

A dacryolith (red arrow) within the swollen right lacrimal sac (yellow arrow).

Parapharyngeal Spaces

List of contents

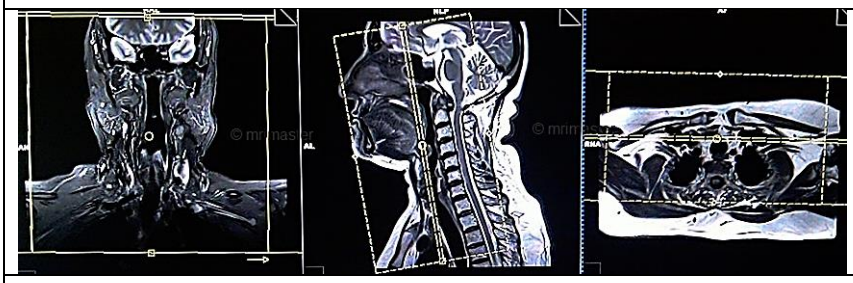
- ❖ Parapharyngeal Spaces
  1) Pharyngeal mucosal space
     a. Nasopharynx
     b. Oropharynx
  2) Carotid space
  3) Parotid space
  4) Masticator space
  5) Buccal space
  6) Visceral space
     a. Larynx
     b. Thyroid
  7) Parapharyngeal fat space
  8) Posterior cervical fat space
  9) Retropharyngeal space
  10) Perivertebral space
     a. Pre-vertberal space
     b. Para-verterbral space
  11) Oral cavity
     a. Oral mucosal space
     b. Submandibular space
     c. Sublingual space
     d. Root of tongue
- ❖ Mandible
- ❖ Cervical LNs
- ❖ Perineural spread

Facial & Neck Technique

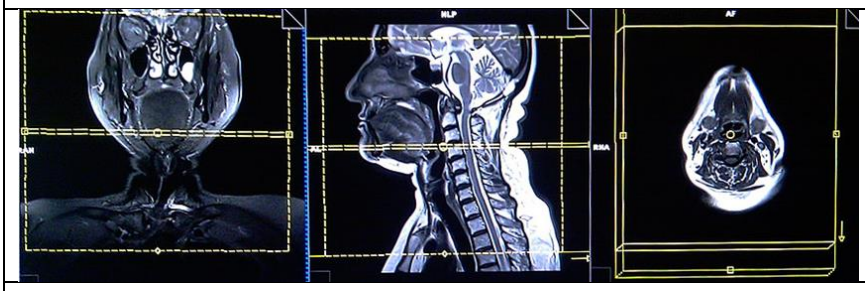
MRI Protocol

Axial T1	Head & neck coil
Axial T2 FS/SPIR	FOV = 28 – 30 cm
Coronal T1	Slice thickness = 4 mm
Coronal STIR	Slice gap = 0.5 mm
Sagittal T2	From frontal sinus to clavicle
	Coronal
Post contrast	// Cervical spine
Axial T1 FS	**Axial**
Coronal T1 FS	⊥ Cervical spine
Sagittal T1 FS	**Sagittal**
Axial DWI	// Midline of the brain

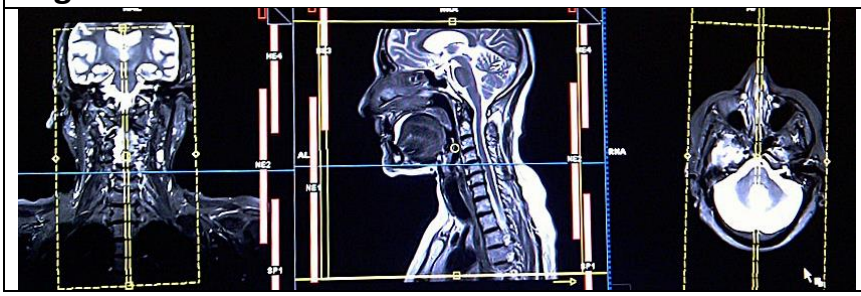
Coronal



Axial



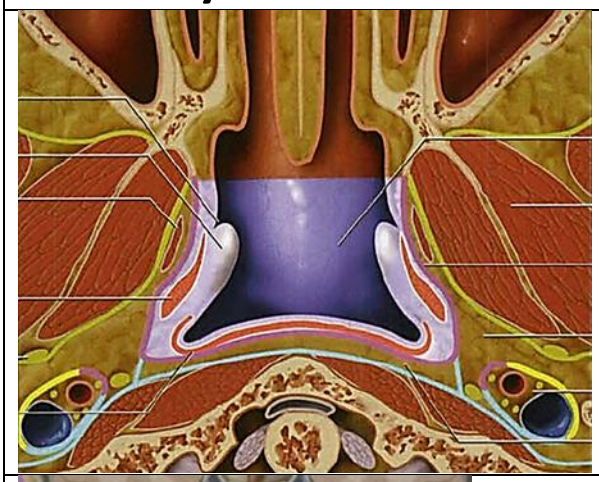
Sagittal



I. Pharyngeal Mucosal Space

1) Nasopharynx

Anatomy

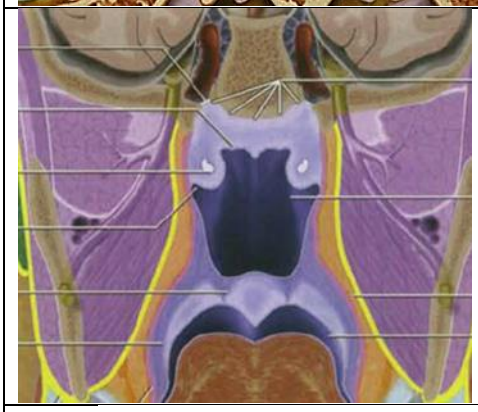


3 layers:

1) Pharyngeal mucosa
2) Pharyngeal muscles
3) Pharyngeal fascia (Deep layer of deep cervical fascia)

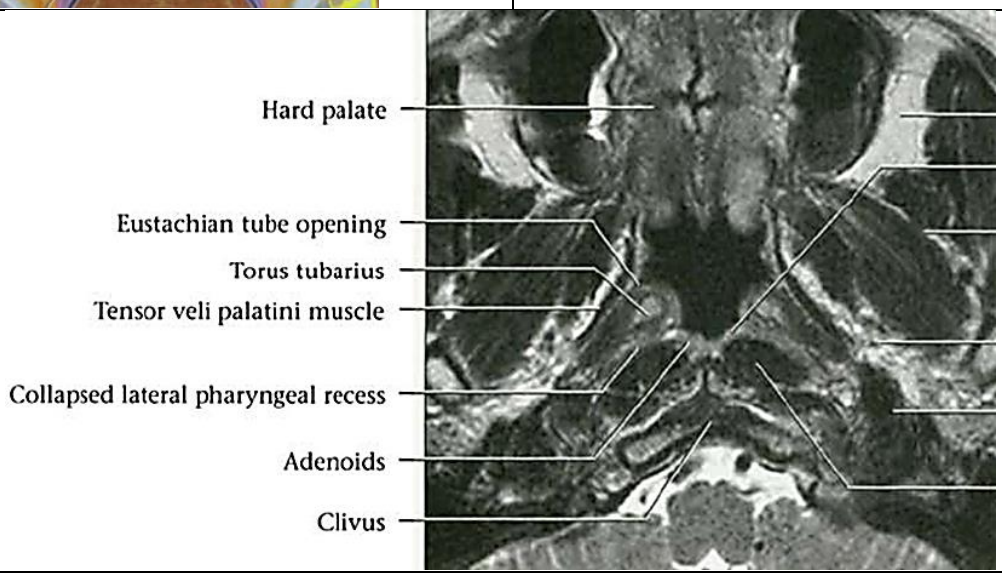
3 Roof = Skull base:

1) Clivus:
    a. Basisphenoid (sphenoid sinus floor)
    b. Basiocciput (anterior clivus)
2) Foramen lacerum



3 Lateral wall:
from posterior to anterior:
from cranial to caudal:

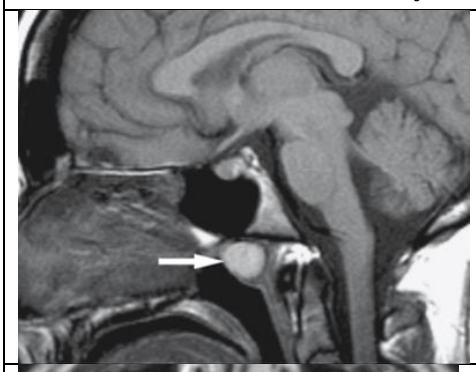
1) Lateral pharyngeal recess (Fossa of Rosenmuller)
2) Torus tubarius (cartilaginous end of Eu. Tube)
3) Orientation of Eustachian Tube.

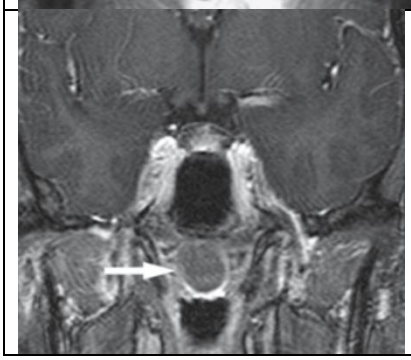


A- Nasopharyngeal Cystic Lesions

Tornwaldt's Cyst	RETENTION CYST
Midline	Posterolateral
Posterior wall	Lateral pharyngeal recess
Well defined	Well defined
Unilocular cyst	Uni or Multi-locular

T1: Intermediate – High signal due to high proteinaceous content
T2: High signal
T1+C: No Enhancement +/- marginal enhancement





B- Nasopharyngeal Solid Lesions				
Adenoid Hypertrophy	**NHL**	**Rhabdomyo sarcoma**	**Angiofibroma**	**Carcinoma**
Children	Any age Adults > Pediatric	Children	Teenage	Adults
	M > F	M>F = 2:1	Males	M>F = 3:1
Diffuse Symmetrical enlargement	Diffuse enlargement		Unilateral; Centered on sphenopalatine foramen	Unilateral; Centered on fossa of Rosenmuller
ET dysfunction / obstruction => Middle ear and mastoid effusion				
No intracranial extension No bone destruction No deep invasion		Intracranial extension via: Skull base destruction – Foramina Invasion Invasion of deep structures		
No LNs	Multiple groups of LNs	No LNs	No LNs	Retropahryngeal + Level II LNs

Adenoid + Tonsil Hypertrophy

Age: Childhood

Clinical Picture:

Nasal congestion: adenoid facies
Chronic or recurrent otitis media
Swallowing difficulties
Speech anomalies
Rhinorrhea
Sleep-disordered breathing

Most common infections:

Haemophilus influenzae
Group A beta-hemolytic Streptococcus Staphylococcus aureus
Moraxella catarrhalis
Streptococcus pneumoniae

Waldeyer's lymphatic ring

Nasopharygeal adenoids
Palatine tonsils
Lingual tonsils

If no adenoidal tissue after 6 months
⇨ Suspect immune deficiency
If enlarged adenoids after childhood
⇨ Suspect lymphatic malignancy (Lymphoma – Leukemia)

Lateral Neck X-ray:

- Size of adenoid is not so important
- Degree of nasopharyngeal obstruction is more important
- Nasopharyngeal air stripe < ½ soft palate => Significant obstruction

CT Nasopharynx:

Symmetrical enlargement of the nasopharyngeal tissue encroaching on the nasopharyngeal air column.

Juvenile Nasopharyngeal Angiofibromas

- Locally aggressive vascular tumor
- Males teenage
- Unilateral epistaxis
- The lesion arise from the region of the sphenopalatine foramen

Radiological Features:

- Lobulated mass
- Centered on the sphenopalatine foramen (which is often widened)
- Typically bowing the posterior wall of the maxillary antrum anteriorly.
- Bone remodeling and resorption.
- T2: Salt and pepper appearance
- T1+C: Marked enhancement
- Prominent flow-voids

Pathways of spread:

→ **Medially => Sphenopalatine foramen => Nasal fossa + Nasopharynx**

→ **Laterally => Pterygopalatine fossa**

- ⇨ **Pterygomaxillary fissure => Masticator space.**
- ⇨ **Inferior orbital fissure => Orbital apex**

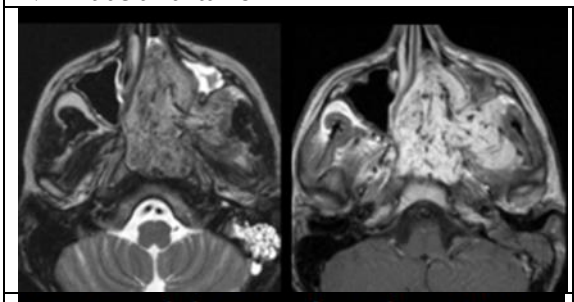
→ **Anteriorly => Anterior displacement of the posterolateral wall of the maxillary sinus = Holman-Miller sign**

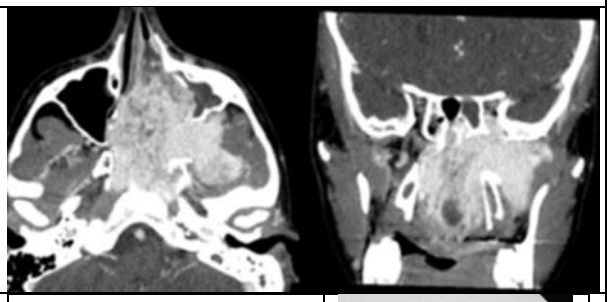
→ **Cranially => Intracranial extension via:**

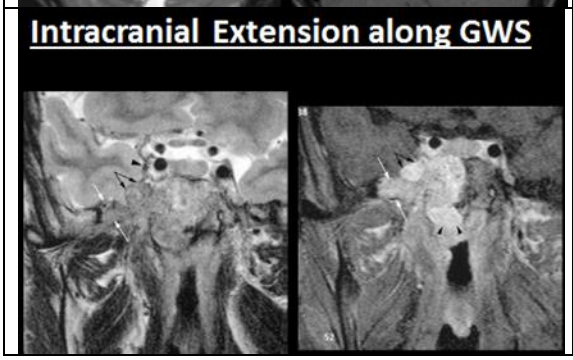
- ⇨ **Erosion of the sphenoid sinus floor => Sphenoid sinus**
- ⇨ **Foramen rotundum**
- ⇨ **Erosion of GWS**

Chandler et al Staging:

I - Tumor confined to nasopharyngeal vault.
II - Tumor extends into nasal cavity or sphenoid sinus
III - Tumor extends into antrum, ethmoid sinus, pterygomaxillary fissure, orbit, and/or cheek
IV - Intracranial tumor

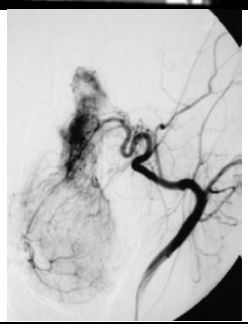






DSA:
Vascular feeder arise from
ECA (majority)

- ⇨ **Internal maxillary**
- ⇨ **Ascending pharyngeal**



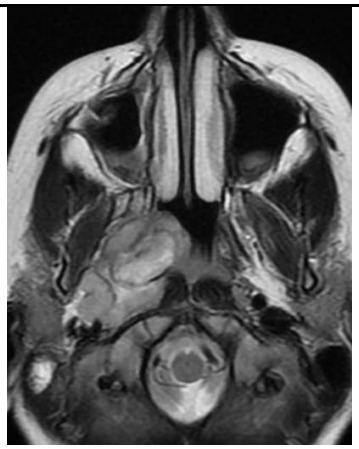
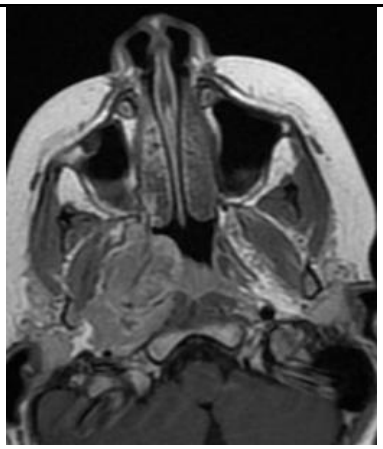
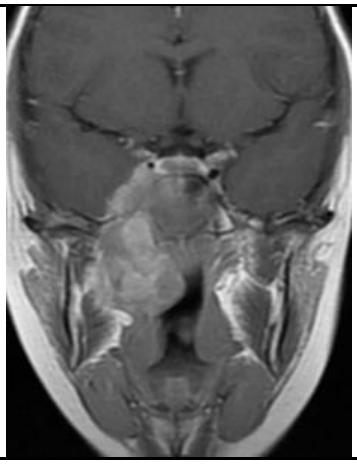
Rhabdomyosarcoma

Incidence: Most common soft tissue tumour in children. 2nd most common pediatric tumor in H&N after lymphoma Age: Children Sex: M>F = 2:1	• Head and neck: 50% • Orbit: ~20% • Oro/nasopharynx, palate: ~15% • Sinuses, mastoid, middle ear: ~15% • GU: ~25% • Extremities: ~15%

Pathology:
• Embryonal rhabdomyosarcoma
  ○ Spindle cell: 50-66%
  ○ Botryoid: 5-10% (best prognosis)
  ○ Anaplastic
• Alveolar: 20%
• Pleomorphic: 5%
	Radiological features:
	CT: Bone destruction
	T1: Low – Intermediate signal
	T2: High signal
	T1+C: Moderate heterogeneous enhancement

Spread:

- Laterally: encroaching upon para-pharyngeal fat
- Posteriorly: infiltrate prevertebral muscles (longus coli)
- Cranially: intracranial extension via destruction of skull base and through foramina.
- Obstruction of ET => Serous otitis media & mastoiditis

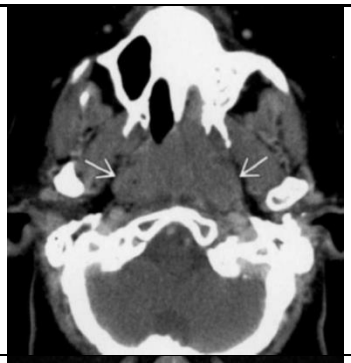
Nasopharyngeal NHL

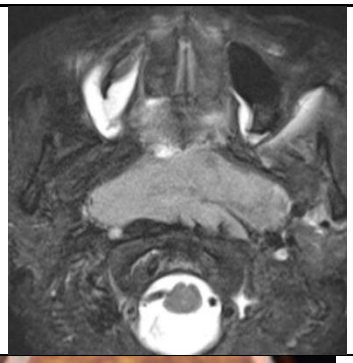
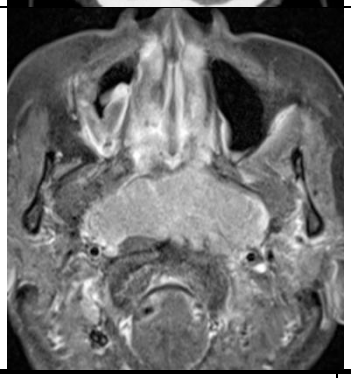
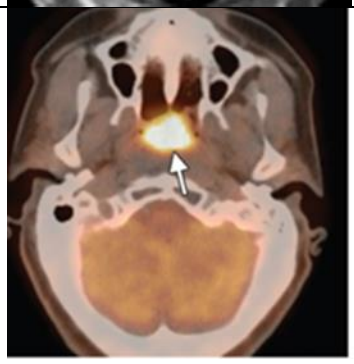
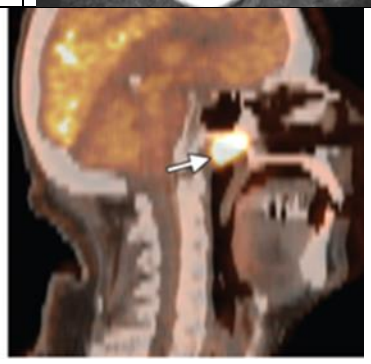
- Waldeyer's ring is the most common site of extranodal NHL in the head and neck region.
- Adults > pediatric
- M>F

Waldeyer's lymphatic ring
Nasopharygeal adenoids
Palatine tonsils
Lingual tonsils

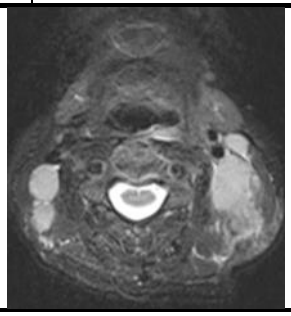
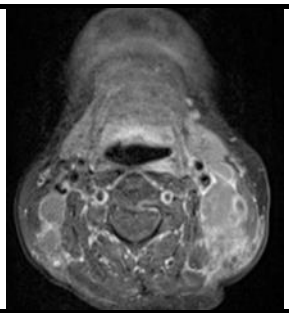
Radiological Features:
CT: Homogenous mass
T1: Low signal
T2: Intermediate signal
+C: Homogenous enhancement
DWI: Restricted
ADC: low value

- Diffusely involve all the nasopharyngeal walls
- Spread in an exophytic fashion to encroach upon the nasopharyngeal airway
- Multiple groups of LNs



Multiple enlarged and enhancing cervical LNs

Nasopharyngeal Carcinoma

- Incidence: Most common primary malignancy of the nasopharynx.
- Most common: Squamous cell Ca.
- Less common: Minor salivary gland tumors
- Age: 40 – 60y
- Sex: M > F = 3:1

Soft tissue masses centered at the lateral nasopharyngeal recess (Fossa of Rosenmüller)

Radiological Features:

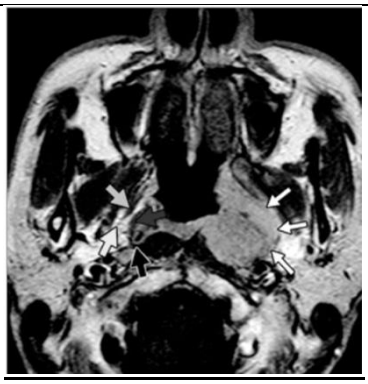
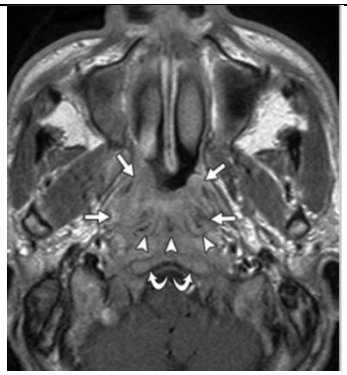
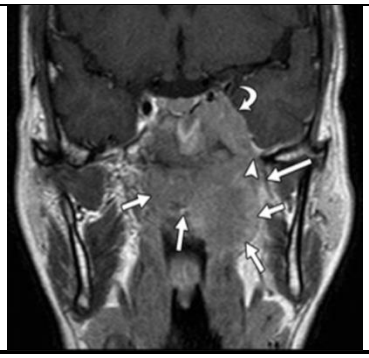
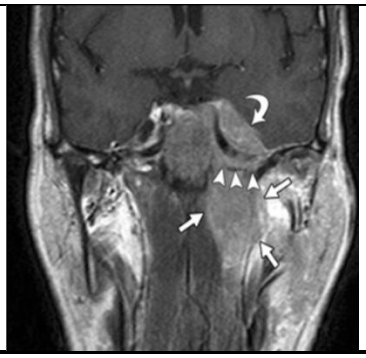
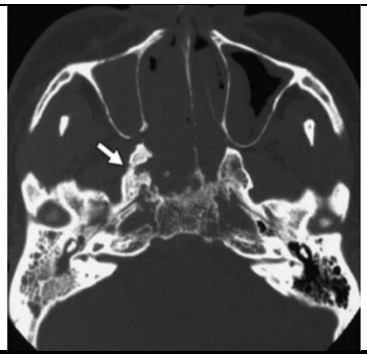
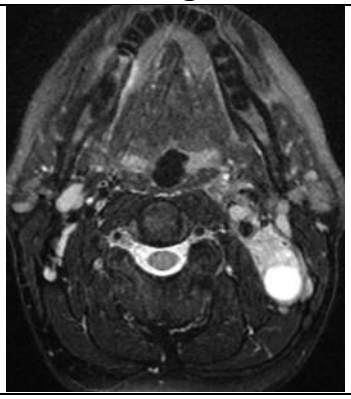
CT: Skull base destruction + Sclerosis
T1: Hypointense signal
T2: Intermediate signal > Muscles
T1+C: Mild/Moderate heterogeneous enhancement < mucosa
ADC: Low but > Lymphoma

Spread:

- Anterior => ET obstruction => serous otitis media and mastoiditis
- Anterior => Nasal cavity => Spheno-palatine foramen => Pterygopalatine fossa:
    - Pterygoid plate destruction or sclerosis
    - Pterygoid muscles infiltration
    - Ptergomaxillary fissure => Masticator space
    - Inferior orbital fissure => Orbital apex
    - F. rotundum & Vidian canal => middle cranial fossa
- Lateral => encroaching upon the parapharyngeal space (PPS) => Masticator space => Parotid space.
- Posterolateral => encasement of ICA in carotid space
- Posterior => Retropharyngeal space => Prevertebral space => infiltration of prevertebral muscles => Clivus destruction.
- Inferior => oropharyngeal soft palate & faucial tonsils
- Superior => Intracranial extension via: clivus, sphenoid sinus, ET, Foramen lacerum-ICA (perivascular) & Foramen ovale-V3 (perineural)

TNM Staging

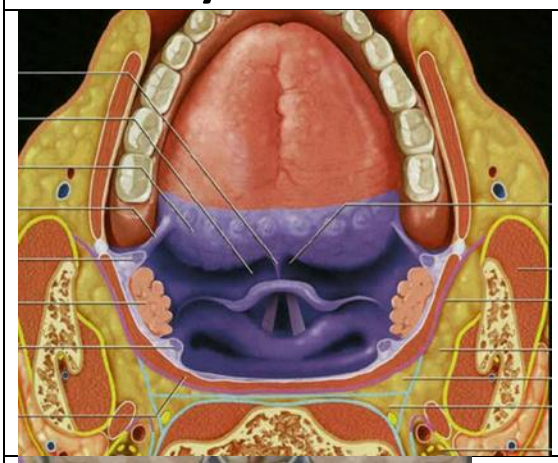
T1: Tumor confined to nasopharynx
T2: Tumor extends to oropharynx or nasal cavity
T2a: Without parapharyngeal extension
T2b: With parapharyngeal extension
T3: Tumor invades skull base or PNS
T4: Tumor extends to: Intracranially – Cranial nerves – Masticator space – Hypopharynx – Orbit.

Tumor centered on Fossa of Rosenmüller	Laterally => Tumor extend to parapharyngeal fat space	Posteriorly => Tumor extend to prevertebral space: Infiltrating longus muscles + Clivus
		
Intracranial extension via Skull base + F.ovale + Cavernous sinus invasion	Intracranial extension via F.Lacerum invasion =>ICA encasement	Sphenoid bone destruction Pterygoid plate sclerosis
		
LNs		
Lateral retropharyngeal LNs **>5mm short axis diameter** **>8mm long axis diameter**	**Upper deep cervical level II LNs** **>11mm short axis diameter** **>15mm long axis diameter**	
		

I. Pharyngeal Mucosal Space

2) Oropharynx

Anatomy

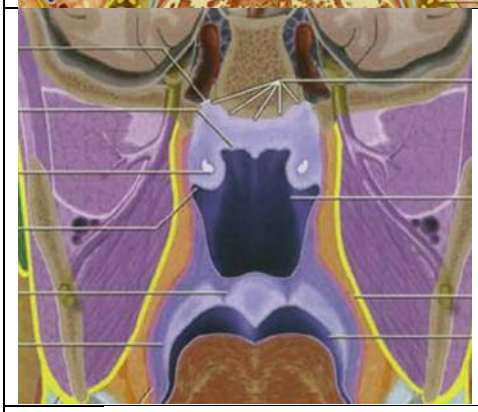


3 layers:

4) Pharyngeal mucosa
5) Pharyngeal muscles
6) Pharyngeal fascia (Deep layer of deep cervical fascia)

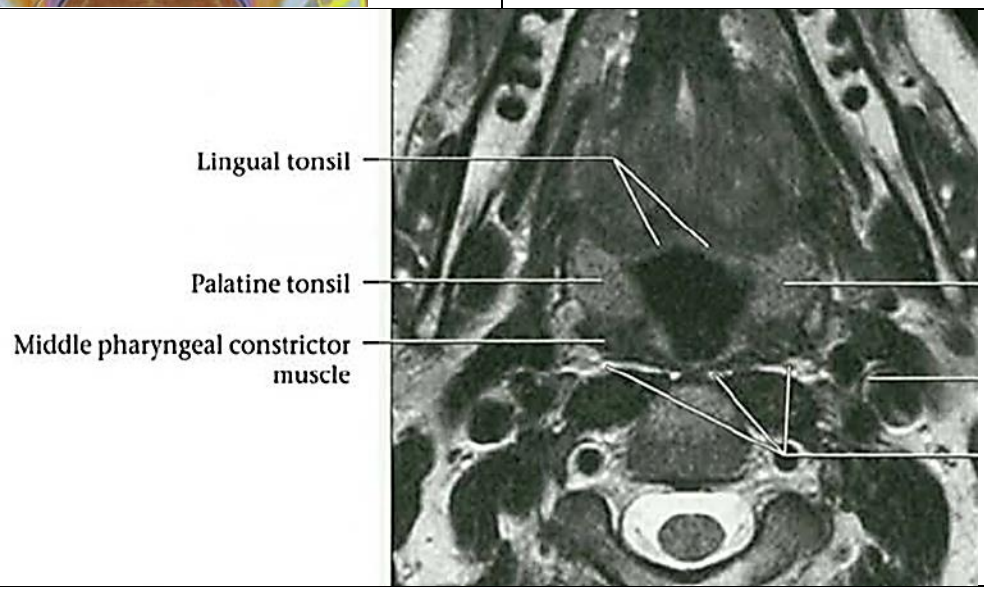
3 Anetrior Wall:

2) Posterior 1/3 of tongue
3) Lingual tonsils
4) Soft palate



3 Lateral wall:

4) Anterior tonsillar pillar
5) Palatine tonsils
6) Posterior tonsillar pillar

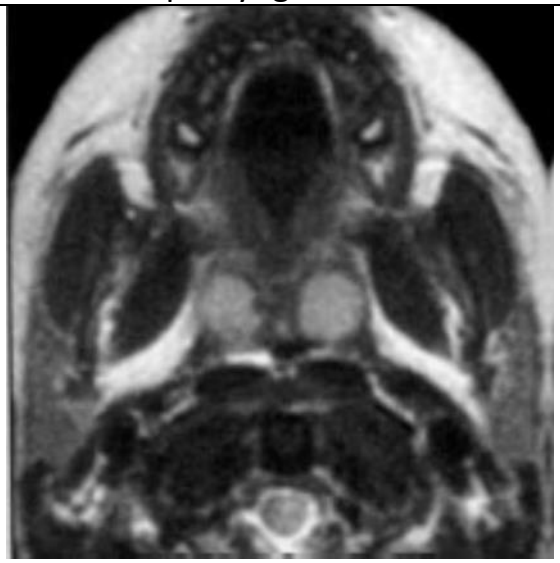


A- Tonsil Lesions

Tonsil Hypertrophy	NHL	Tonsillitis	Peritonsillar Abscess	Carcinoma
Children	Any age Adults >Pediatric	Children		Age > 40y M > F
Diffuse enlargement of tonsils			Well defined focal tonsillar collection	Ill-defined lesion
Preserved para-pharyngeal fat space	Effacement of PPS	Smudging of para-pharyngeal fat planes		Infiltration of PPS
No deep invasion - No bone destruction				Deep invasion
Homogenous enhancement		Heterogeneous / Striated enhancement	Marginal enhancement	Heterogeneous enhancement
No LNs	Multiple groups of LNs	Drainage group of LNs		

Adenoid + Tonsil Hypertrophy

Age: Childhood

Clinical Picture:	**Most common infections:**
Nasal congestion: adenoid facies Chronic or recurrent otitis media Swallowing difficulties Speech anomalies Rhinorrhea Sleep-disordered breathing	Haemophilus influenzae Group A beta-hemolytic Streptococcus Staphylococcus aureus Moraxella catarrhalis Streptococcus pneumoniae
Waldeyer's lymphatic ring Nasopharygeal adenoids Palatine tonsils Lingual tonsils	If no adenoidal tissue after 6 months ⇨ Suspect immune deficiency If enlarged adenoids after childhood ⇨ Suspect lymphatic malignancy (Lymphoma – Leukemia)
Lateral Neck X-ray: ○ Palatine tonsil is seen as soft tissue prominence or mass posterior - inferior to soft palate	**CT Oropharynx:** Symmetrical enlargement of the tonsils (Kissing tonsils) encroaching on the oropharyngeal air column.
	

Tonsillitis

is one of the most common head and neck infections in adolescents and young adults.

Causative organism:

- Most commonly bacterial (group A beta-haemolytic Streptococci)
- Viral infections (herpes virus, cytomegalovirus, adenovirus)

Radiological features:

- Diffuse enlargement of tonsils => Kissing tonsils => encroaching on the oropharyngeal air column.
- Striated contrast enhancement
- Stranding of the para-pharyngeal fat space
- No focal fluid collection
- Reactive bilateral upper deep cervical LNs

Peritonsillar Abscess = Quinsy

Radiological features:

Enlarged tonsil + Central fluid collection
Marginal enahncment
Stranding of the para-pharyngeal fat space
Reactive bilateral upper deep cervical LNs

Tonsillar NHL

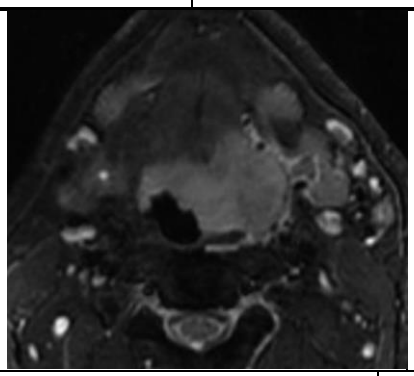
- Waldeyer's ring is the most common site of extranodal NHL in the head and neck region.
- Adults > pediatric
- M>F

<u>Waldeyer's lymphatic ring</u>
Nasopharygeal adenoids
Palatine tonsils
Lingual tonsils

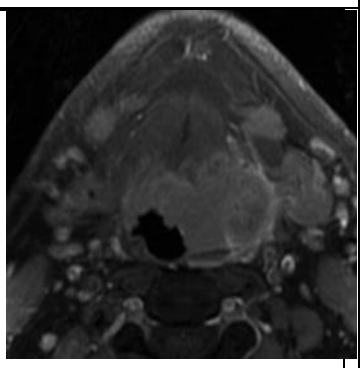
<u>Radiological Features:</u>
CT: Homogenous mass
T1: Low signal
T2: Intermediate signal
+C: Homogenous enhancement
DWI: Restricted
ADC: Low value
PET-CT: Avid FDG uptake

- Diffuse enlargement of tonsils
- Effacement of para-pharyngeal fat space.
- +/- invade lingual tonsils and soft palate.
- Multiple groups of cervical LNs

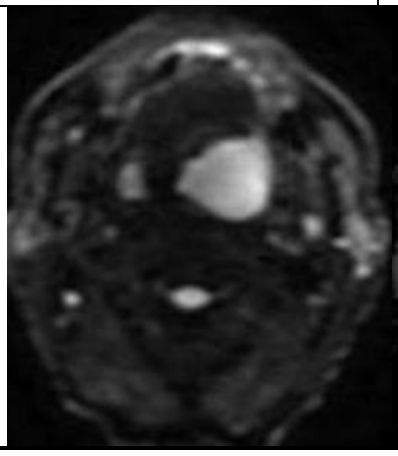
Restricted Diffusion

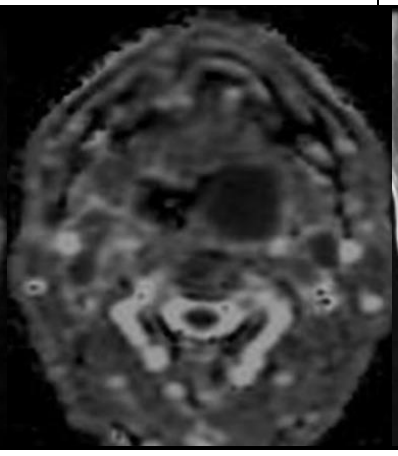


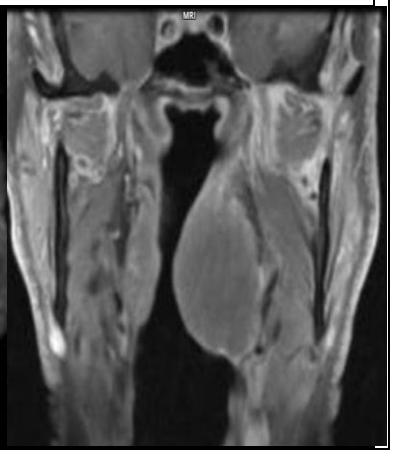
Low ADC value



Coronal T1+C FS







Tonsillar Carcinoma

• 2nd most common malignancy in H&N after larynx • Most common: Squamous cell Ca. • Less common: Minor salivary gland tumors • Age: > 40y • Sex: M> F	CT: Heterogeneous lesion T1: Hypointense signal T2: Intermediate signal > Muscles T1+C: Mild/Moderate heterogeneous enhancement < mucosa ADC: Low but > Lymphoma

Tonsillar subsites:

- Anterior tonsillar pillars (palatoglossus muscle)
- Posterior tonsillar pillars (palatopharyngeus muscle)
- Palatine tonsils.

Radiological Features:

- Ill-defined infiltrative tonsillar lesion
- Encroaching on the oropharyngeal air column
- Para-pharyngeal fat infiltration + Deep invasion and spread.
- Ipsilateral cervical lymphadenopathy

Bone Involvement:

- CT: Cortical erosion + Perosteal reaction + Ill defined medullary osteolytic lesion
- T1: Replacement of the medullary high T1 signal of fatty marrow with low signal of the tumor
- STIR: ill defined high medullary signal
- T1+C FS: ill defined enhancing medullary lesion

Perineural Spread:

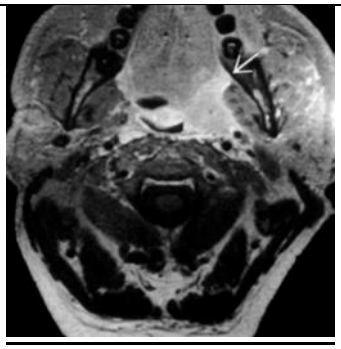
- **Direct signs:**
  - CT: foraminal enlargement
  - T1: Replacement of the high signal of the foraminal fat with low signal of the tumor
  - STIR: Enlarged high signal nerve
  - T1+C FS: Enlarged enhancing nerve
- **Indirect signs:**
  - Fatty atrophic muscle changes supplied by the nerve
  - Tumor lesions at some distance from 1ry site; in neural cross roads (eg: Ptergopalatine fossa and Meckel's cave)

Spread:

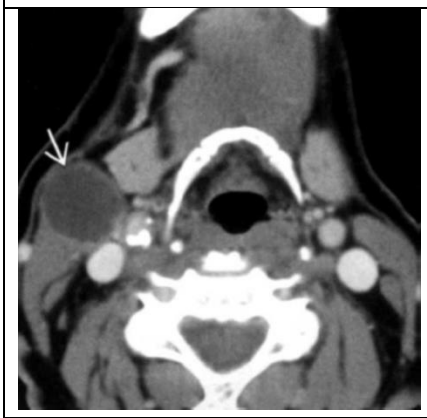
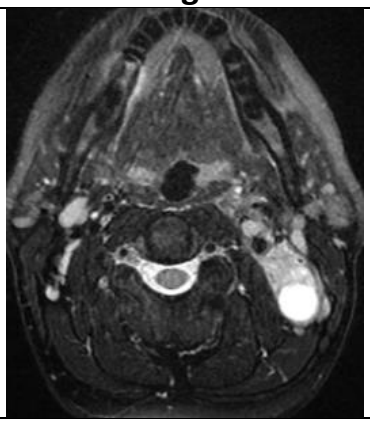
- Cranially => Nasopharynx
- Caudally => Hypopharynx
- Anteriorly => Tumor spread along the palatoglossus muscle
    - Tongue base
    - Soft palate
- Antero-laterally => Tumor spread along Pterygo-mandibular raphe
    - ⇨ Retromolar trigone invasion:
        - Mandibular cortical erosion + medullar invasion
        - Perineural spread along inferior alveolar nerve
    - ⇨ Pterygopalatine fossa invasion:
        - Pterygoid plate destruction or sclerosis
        - Pterygoid muscle infiltration
        - Pterygo-maxillary fissure => Masticator space
        - Inferior orbital fissure => Orbital apex
        - Perineural spread along F. rotundum (V2) & Vidian canal => middle cranial fossa
- Lateral => encroaching upon the parapharyngeal space (PPS) => Masticator space:
    - Mandibular cortical erosion + Medullary invasion
    - Masticator muscle invasion
    - Perineural spread along mandibular nerve (V3)
- Posterolateral => encasement of ICA in carotid space
- Posterior => Retropharyngeal space => Prevertebral space

TNM Staging

T1: Tumor < 2cm in its maximum dimension
T2: Tumor 2-4 cm in its maximum dimension
T3: Tumor > 4cm in its maximum dimension
T4a: Tumor involves the larynx, intrinsic or extrinsic muscles of the tongue, medial pterygoid, hard palate, mandible
T4b: Tumor involves lateral pterygoid muscle, pterygoid plates, lateral nasopharynx, skull base, carotid artery

Axial T1	Axial T2 FS	Axial T1 +C FS
Anterior tonsillar pillar tumor => extending along pterygp-mandibular raphe	Laterally => Tumor infiltrate parapharyngeal fat space => Masticator space	Anterolaterally => Tumor along the pterygo-mandibular raphe
		

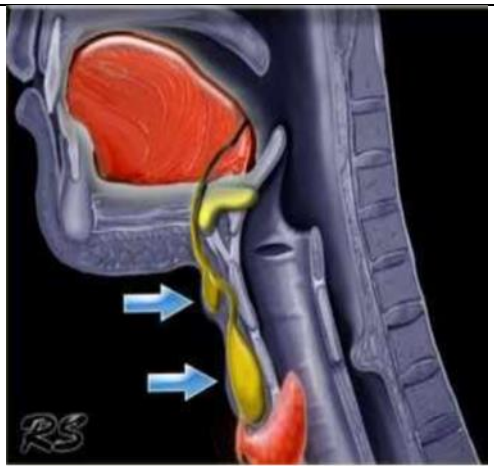
<u>LNs</u>

Enlarged LN with central necrosis	**Upper deep cervical level II LNs** **>11mm short axis diameter** **>15mm long axis diameter**
	

B. Base of Tongue Lesions			
Thyroglossal Duct Cyst	**Lingual Thyroid**	**NHL**	**Carcinoma**
Congenital	Congenital	An age Adults > Pediatric	Adults > 30y
Well defined Midline Cyst	Well defined midline soft tissue lesion	Diffuse soft tissue lesion	Ill defined infiltrative lesion
Fluid density or signal	NCCT: Hyperdense	Soft tissue density or signal	Soft tissue density or signal
No enhancement	Marked enhancement	Mild / Moderate homogenous enh.	Mild / Moderate heterogeneous enh.
Preserved surrounding fat lanes		Effacement of the surrounding fat planes	Infiltration of the surrounding fat planes
No deep invasion No bone destruction			Deep invasion Bone destruction
No LNs	No LNs	Multiple groups of LNs	Drainage groups of LNs

Thyroglossal Duct Cyst

Congenital neck cyst
Present during childhood

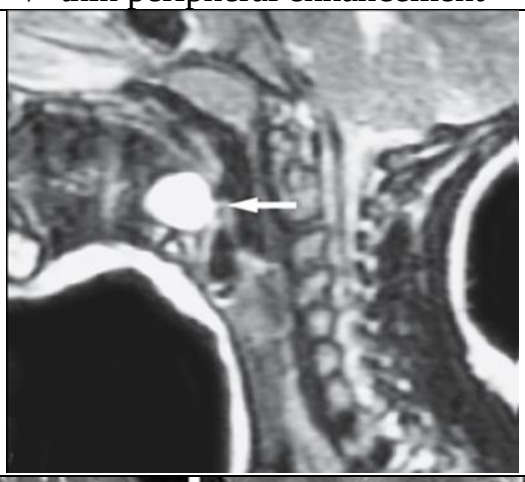


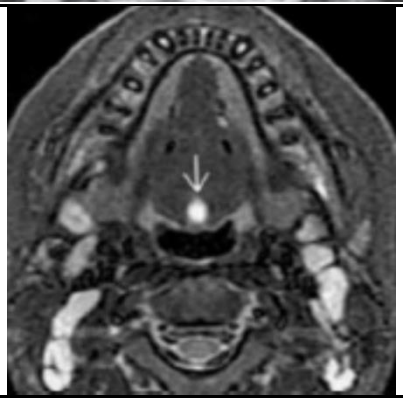
Thyroglossal duct
runs from the base of tongue at the foramen caecum to the thyroid gland

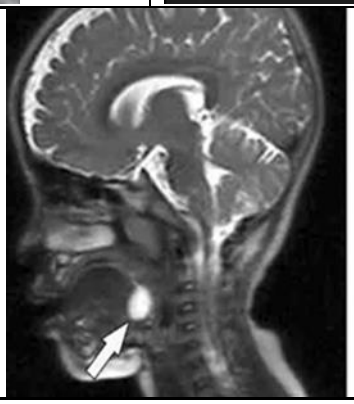
Location:
65% Infrahyoidal
20% suprahyoidal
15% juxtahyoid
2% Lingual

Radiological Features:
Midline / Para-midline
Well defined cyst

T1: High signal due to high proteinaceous content
T2: High signal
+C: No enhancement
+/- thin peripheral enhancement

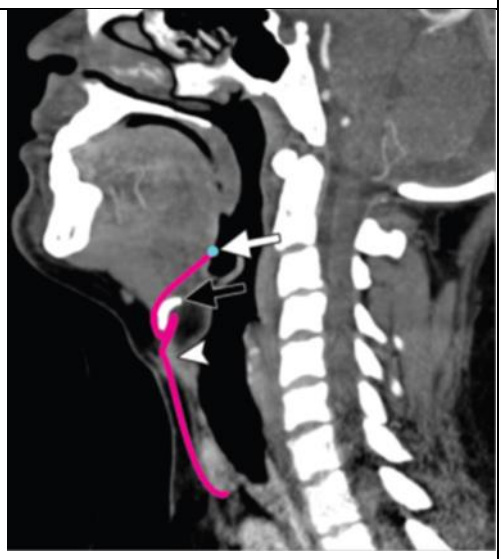






Lingual Thyroid

Congenital
F > M



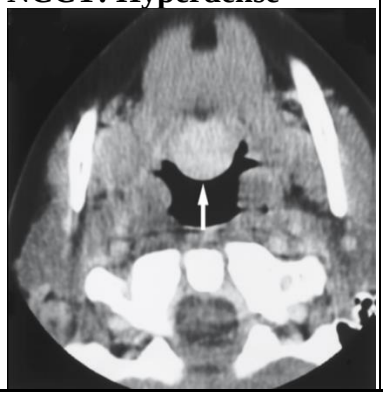
Thyroid Caudal Migration:
Runs from the base of tongue at the foramen caecum down to its normal location anterior to larynx and upper trachea.

Ectopic Thyroid Location:
Lingual 90%
Juxtahyoid
Infrahyoid
Lateral neck

Radiological Features:
Midline well defined soft tissue mass
NCCT: Hyperdense (70 HU) + Calcification
CECT: Avid homogenous contrast enhancement
T1: iso – Hyper compared to muscles
T2: Mild hyper
T1+C: Mild homogenous contrast enhancement

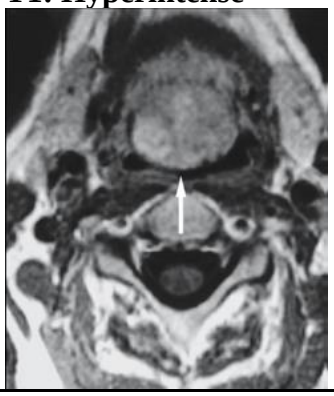
Orthotopic thyroid absent 70%–80%

NCCT: Hyperdense



CECT: Avid enh

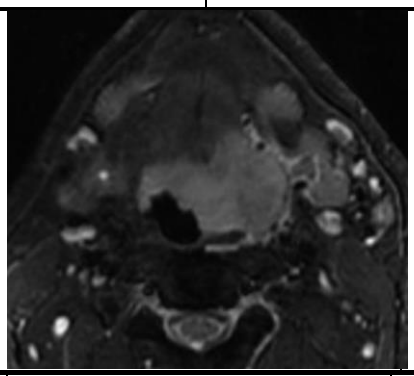
T1: Hyperintense



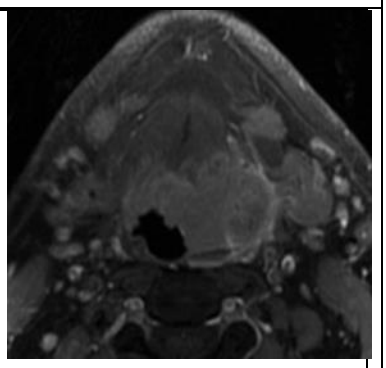
Lingual NHL

• Waldeyer's ring is the most common site of extranodal NHL in the head and neck region. • Adults > pediatric • M>F	**<u>Waldeyer's lymphatic ring</u>** Nasopharygeal adenoids Palatine tonsils Lingual tonsils
<u>Radiological Features:</u> CT: Homogenous mass T1: Low signal T2: Intermediate signal +C: Homogenous enhancement DWI: Restricted ADC: Low value PET-CT: Avid FDG uptake	• Diffuse enlargement of lingual tonsils • Multiple groups of cervical LNs

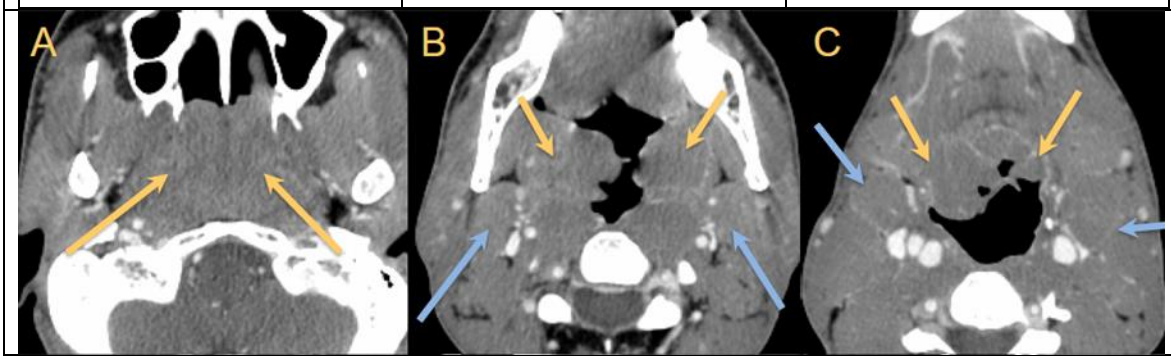
Nasopharyngeal adenoid



Palatine Tonsils



Lingual tonsils



Tongue Base Carcinoma

- Most common: Squamous cell Ca.
- Age: > 40y
- Sex: M> F

Radiological Features:

- Ill-defined infiltrative lesion in the posterior 1/3 of the tongue
- Deep invasion and spread.
- Crossing midline or not ???
- Ipsilateral cervical lymphadenopathy Level II, III & IV

CT: ill defined heterogeneous lesion
T1: Hypointense signal
T2: Intermediate signal > Muscles
T1+C: Mild/Moderate heterogeneous enhancement < mucosa
ADC: Low but > Lymphoma

Spread:

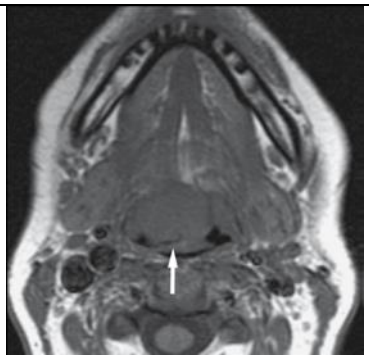
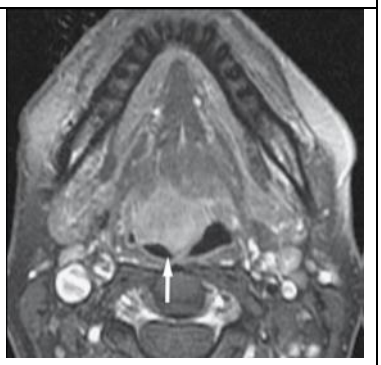
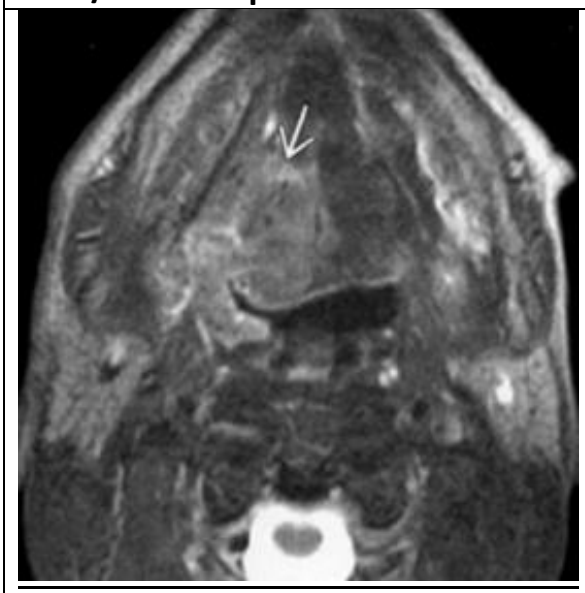
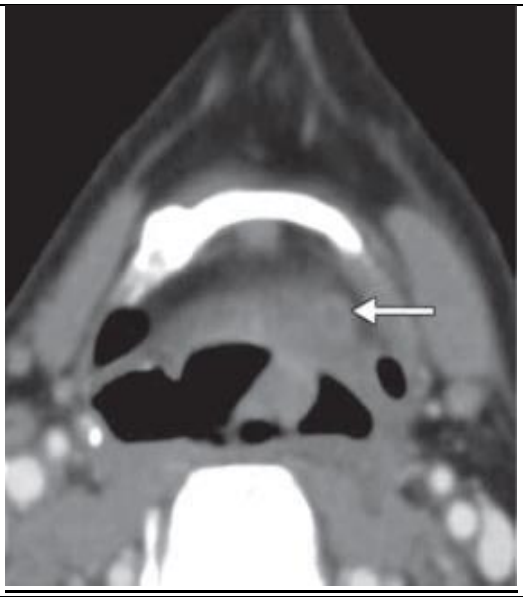
- Anterior:
  - Intrinsic muscles of the tongue body
  - Root of tongue (genioglossus-geniohyoid muscles)
  - Floor of mouth (mylohyoid muscle – lingual neurovascular bundle)
- Posterolateral: Anterior tonsillar pillar, faucial tonsil
- Inferior: Supraglottic larynx & pre-epiglottic space
- Medially: crossing midline

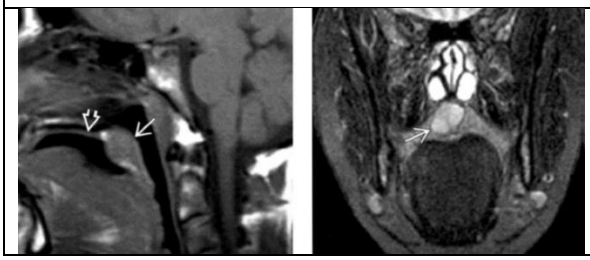
Pre-epiglottic Fat Space Infiltration (T4a) => Axial & Sagittal

- CT: Replacement of the low density of fat by soft tissue density
- T1: Replacement of the high signal of fat by low signal of tumor
- T2 FS: High signal lesion within fat suppressed space
- T1+C FS: Enhancing lesion within fat suppressed space

TNM Staging

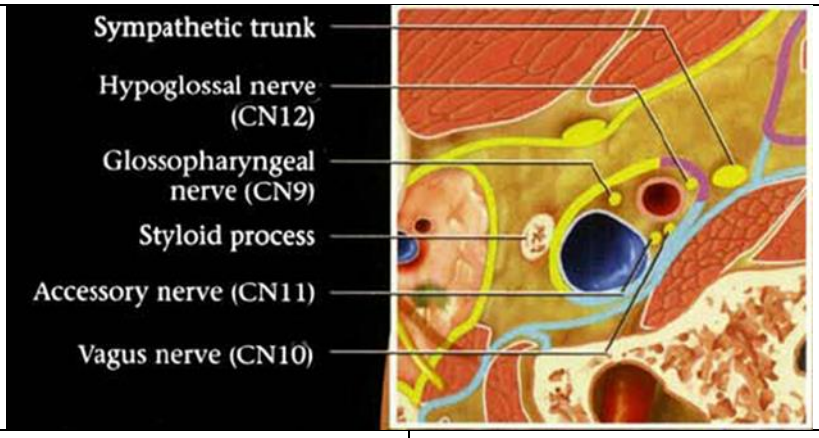
T1: Tumor < 2cm in its maximum dimension
T2: Tumor 2-4 cm in its maximum dimension
T3: Tumor > 4cm in its maximum dimension
T4a: Tumor involves the larynx, intrinsic or extrinsic muscles of the tongue, medial pterygoid, hard palate, mandible
T4b: Tumor involves lateral pterygoid muscle, pterygoid plates, lateral nasopharynx, skull base, carotid artery

Axial CT	Axial T1	Axial T1 +C FS
		
Anterior => Floor of mouth + Neurovascular bundle **Posterior => Lateral oropharyngeal wall /Tonsillar pillars**	**Inferior => Pre-epiglottic space infiltration**	
		

C. Soft Palate Lesions	
Minor Salivary Gland Tumors	
Benign	**Malignant**
Pleomorphic adenoma (Benign mixed Tumor): Most common salivary gland tumor	Adenoid cystic carcinoma Mucoepidermoid carcinoma Adenocarcinoma Low-grade adenocarcinoma
85% in parotid glands 8% in submandibular glands 0.5% in sublingual glands 6.5% of head and neck: Soft palate > > oropharyngeal (lingual or faucial tonsil) > nasopharyngeal	**Low grade:** Well-circumscribed, inhomogeneous mass **High grade:** Invasive, ill-defined mass
Well defined lobulated lesion	Ill defined lesions
No deep invasion	Deep invasion
No bone destruction	Bone destruction
No perineural spread	Perineural spread
No LNs	LNs
	

II. Carotid Space

Anatomy

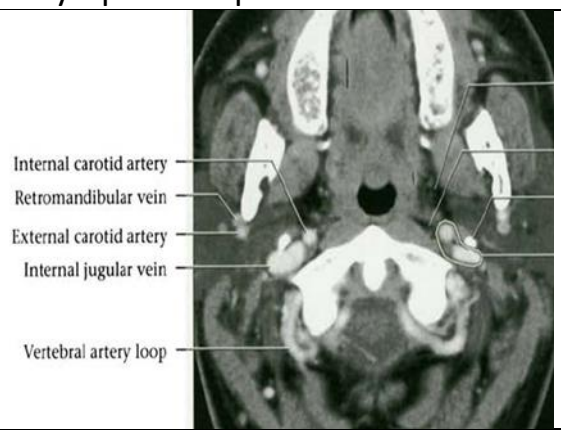


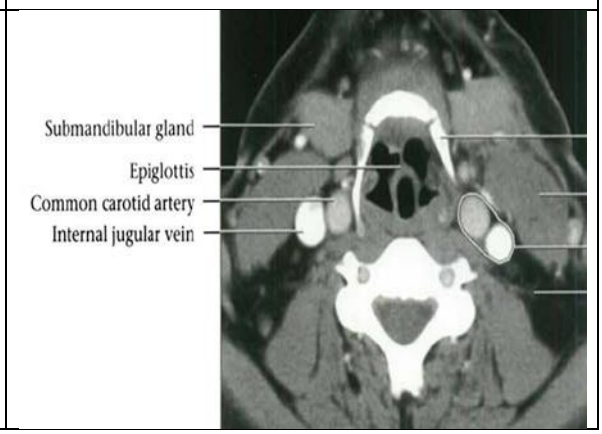
Supra Hyoid Neck Carotid Space

- Internal carotid artery (ICA)
- Internal jugular vein (IJV)
- CN 9-10-11-12
- Sympathetic plexus

Infra Hyoid Neck Carotid Space

- Common carotid artery (CCA)
- Internal jugular vein
- CN 10: Vagus nerve
- LNS



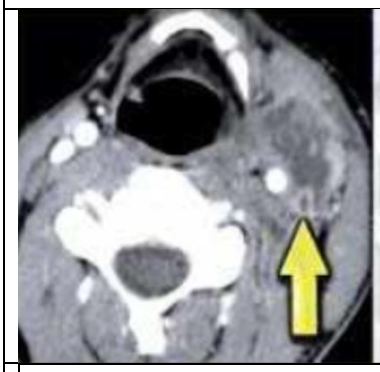


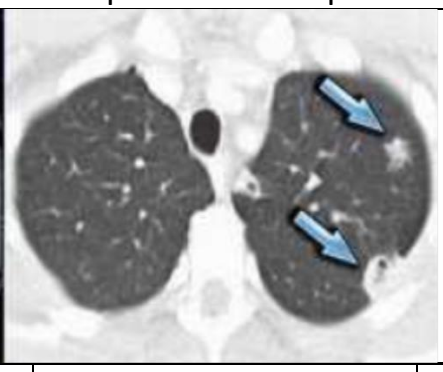
Vascular

IJV Thrombosis

Phlebectasia

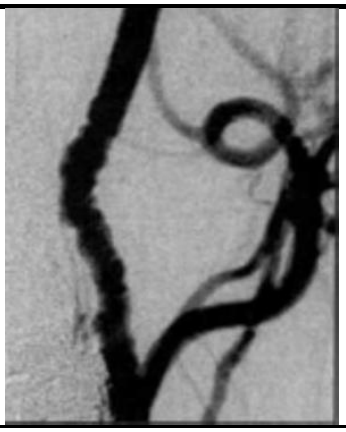
Lemierre syndrome =
Neck infection => IJV thrombophlebitis => Septic emboli





Pseduaneurysm

ICA FMD



Retropharyngeal ICA

<table>
<tr><th colspan="2">Carotid Body</th><th>Glomus Vagale</th><th>Schwannoma</th><th>Neurofibroma</th><th>Neuroblastoma</th></tr>
<tr><td colspan="3">Benign tumor arising from neural crest cells (glomus bodies).</td><td rowspan="2">Benign tumor of the Schwann cells of the nerve sheath.

Age: Middle age
Sex: F > M</td><td></td><td>Pediatric</td></tr>
<tr><td colspan="3">Age= 40-60 y.
F>M = 3:1
Multicentricity 50-90%</td><td>Multiplicity => NF-I</td><td></td></tr>
<tr><td colspan="3">T1 WI = Salt & Pepper
T2WI: Mixed hyperintense mass with hypointense foci ("pepper")</td><td>T1: Low signal.
T2: High signal.
+ Intratumoral cysts</td><td>T1: Low signal
T2: Target sign</td><td>Calcification 10%</td></tr>
<tr><td colspan="3">+C: Intense enhancement</td><td>+C: Mild enh + Nonenhancing Intratumoral cysts</td><td>+C: Target sign</td><td>+C: Mild / Mod enhancement</td></tr>
<tr><td colspan="5">Displace parapharyngeal fat anteriorly
Displace Styloid process anterolaterally
Displace Posterior belly of digastric muscle laterally
Displace ICA , ECA and IJV</td><td>Deep invasion
Bone destruction</td></tr>
</table>

Paraganglioma

Carotid Body Tumor

Benign tumor arising from neural crest cells (glomus bodies).

Age= 40-60 y.
F>M = 3:1
Multicentricity 50-90%

Radiological Features:

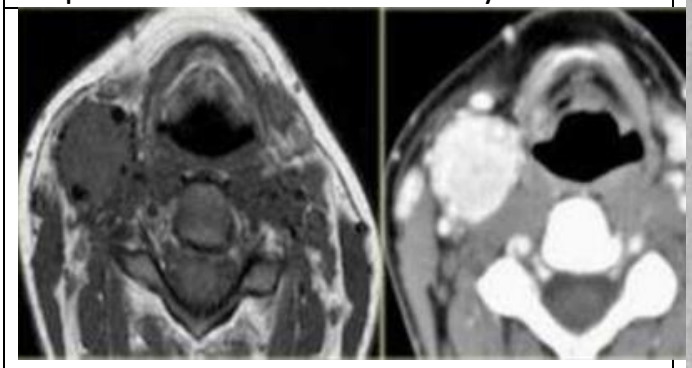
T1 WI = Salt & Pepper
- Salt = hyperintense foci => hemorrhage or slow flow
- Pepper = hypointense foci => high velocity flow voids

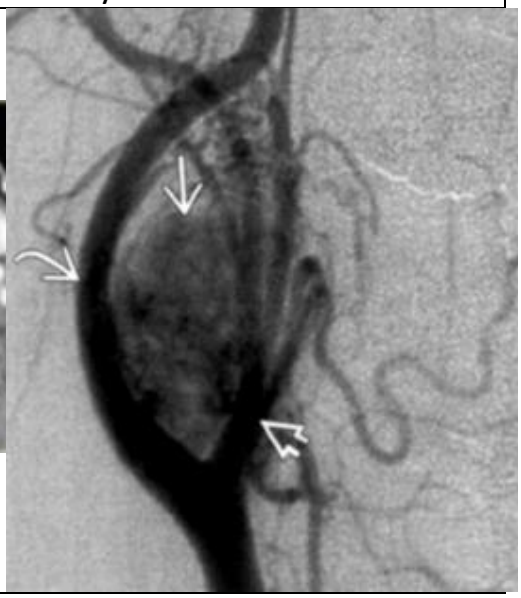
T2WI: Mixed hyperintense mass with hypointense foci ("pepper")
+C: Intense enhancement

Mass centered in carotid bifurcation

Displace parapharyngeal fat anteriorly
Displace Styloid process anterolaterally
Displace Posterior belly of digastric muscle laterally

Displace ECA => Anteromedial
Displace ICA => Posterolaterally





Paraganglioma

Glomus Vagale

Benign tumor arising from neural crest cells (glomus bodies).

Age= 40-60 y.
F>M = 3:1
Multicentricity 50-90%

Radiological Features:

T1 WI = Salt & Pepper
- Salt = hyperintense foci => hemorrhage or slow flow
- Pepper = hypointense foci => high velocity flow voids

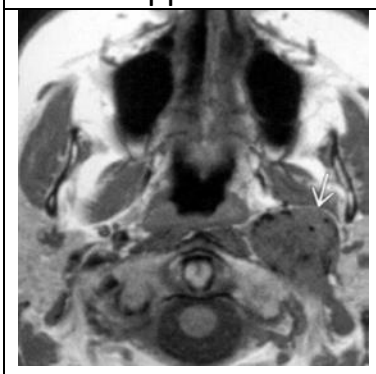
T2WI: Mixed hyperintense mass with hypointense foci ("pepper")
+C: Intense enhancement

Mass extends from jugular foramen to carotid bifurcation.

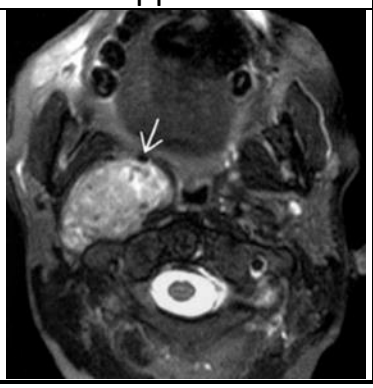
Displace parapharyngeal fat anteriorly
Displace Styloid process anterolaterally
Displace Posterior belly of digastric muscle laterally

Displaces ICA => Anteromedial

T1 => Pepper



T2 => Pepper



Schwannoma

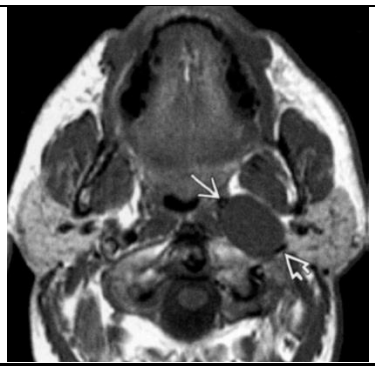
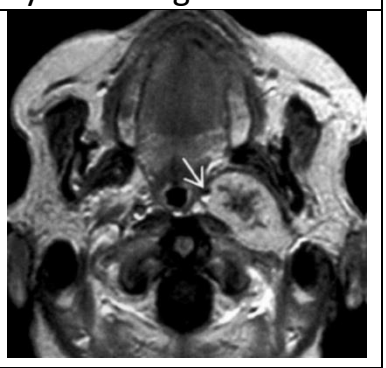
Benign tumor that arises from the Schwann cells of the nerve sheath

Age: Middle age
Sex: F > M
Multiplicity => NF-II

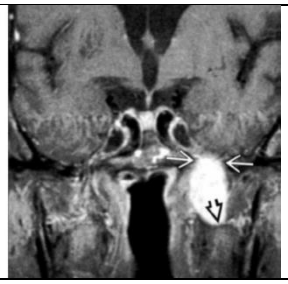
Radiological Features:

Well defined lesion
T1: Low signal. No salt & pepper
T2: High signal. No pepper + Intratumoral cysts
+C: Mild homogenous enhancement + Nonenhancing Intratumoral cysts

Displace parapharyngeal fat anteriorly
Displace Styloid process anterolaterally
Displace Posterior belly of digastric muscle laterally
Displace ICA => Anteromedial

T1: No salt & pepper	T2: Hyperintense + Intratumoral cystic changes	T1+C: Peripheral enh + Central nonenhancing cystic changes
		

Enlarged F. Ovale



2nd Branchial Cleft Cyst

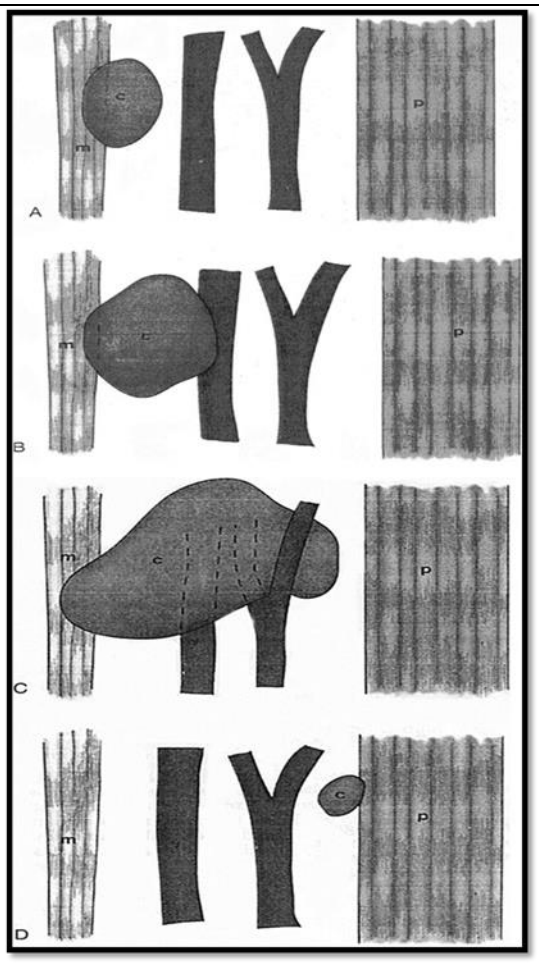
95% of all branchial cleft anomalies

Well defined cyst +/- sinus or fistula

Along anterior surface of sternomastoid muscle
Posterior to submandibular gland

Bailey Classification:

Type I : Cyst away from vessels
Type II: Cyst lateral to carotid space (most common)
Type III: Cyst extends medially between ICA & ECA.
Type IV: Cyst deep to carotid sheath; within parapharyngeal space.



III- Parotid Space

Anatomy:

Parotid fascia:

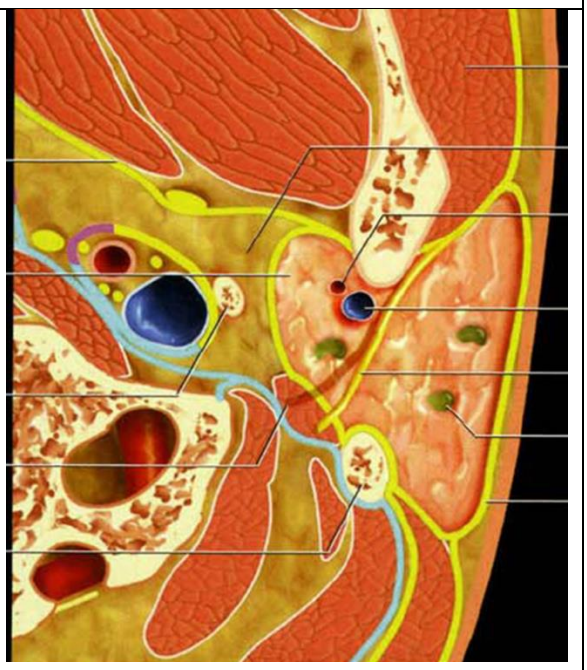
Superficial layer of deep cervical fascia (Investing deep fascia)

2 Parts:

- Superficial lobe: Lateral 2/3 of parotid space
- Deep lobe: projects medially into lateral PPS

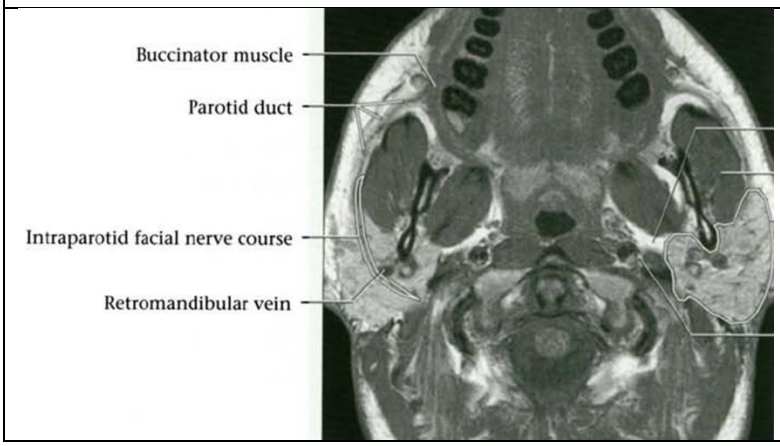
Content from lateral to medial:

- Facial nerve (CN7)
- Retromandibular vein: Lateral, Larger of 2 vessels
- ECA: medial, Smaller of 2 vessels
- Intra-parotid LNs



Superficial VS Deep:

- No anatomic division / No fascia separates the parotid gland into superficial and deep lobes
- Only the plane of facial nerve defines the superficial and deep lobes of the parotid gland (Lateral to retromandibular vein).
- Stylomandibular tunnel: between the styloid process and mandibular ramus.



A- Diffuse Parotid Enlargement

a. Infection

- Acute bacterial sialadenitis (acute parotitis)
- Mumps
- Cat-scratch fever
- HIV parotitis
- Syphilis
- Tuberculosis

b. Inflammatory

- Benign lymphoepithelial lesions
- Chronic recurrent sialadenitis
- Sarcoidosis

c. Immune mediated

- Mikulicz syndrome
- Sjogren syndrome (myoepithelial sialadenitis)

d. Lymphoproliferative

- Leukaemia
- Lymphoma

e. Sialadenosis (Sialosis)

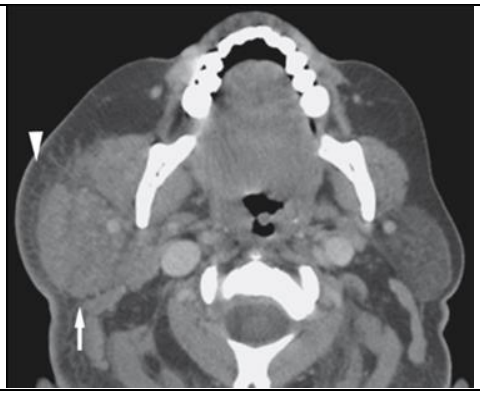
- **Endocrine Disorders**
  - Diabetes Mellitus (1/4)
  - Hypothyroidism
- **Alcoholism (autonomic neuropathy)**
- **Nutritional Disorders**
  - Bulimia (1/3)
  - Protein deficiency (alcoholism)
  - Vitamin deficiency (niacin, thiamine, vit. A)
- **Drug side-effect (adrenergic, cholinergic)**
- **Idiopathic**

Acute Parotitis:

- **Bacterial** = acute suppurative parotitis; Unilateral, localized infection.
- **Viral** = acute viral parotitis; 75% bilateral, systemic viral infection.
- **Calculus-induced** = parotiditis secondary to ductal obstruction from stone; unilateral.

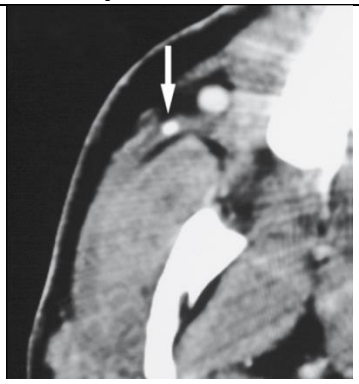
Radiological features:

- Diffuse parotid enlargement.
- Diffuse heterogeneous enhancement.
- Stranding of the overlying fat planes.
- Thickening of the overlying fascia



Proximal Parotid duct stone

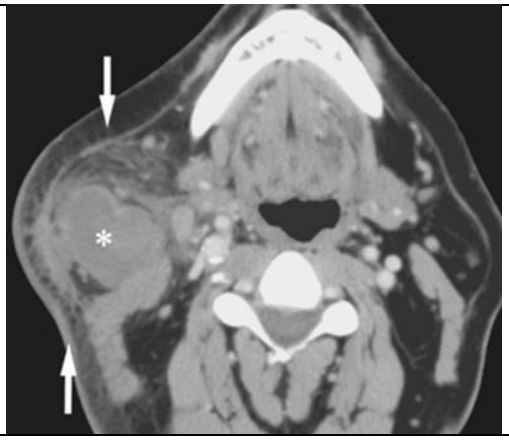
Distal parotid duct stone



Parotid Abscess:

Radiological features:

- Well defined collection
- Marginal enhancement
- Stranding of the overlying fat planes.
- Thickening of the overlying fascia



B- Parotid Cystic Lesions

Sjogren syndrome	Lymphoepithelial lesions	1st Branchial Cleft Cyst	Parotid Abscess	Parotid Lipoma	Metastatic / Suppurative LNs	Warthin Tumor
Multiple + Bilateral Cysts		Solitary + Unilateral Cystic Lesion			Multiple + Unilateral	Unilateral or Bilateral
F Middle age Sicca Syndrome	AIDS patients Triad:	Congenital	Painful swelling	Painless swelling	1ry lesion: Skin of face, External ear Scalp	M >> F Age = 60
1) Parotid 2) Lacrimal Sublingual **3 patterns:** 1) Normal 2) Miliary pattern 3) Large cystic changes	1) Parotid solid + Cystic lesions 2) Enlarged Adenoid + Tonsils 3) Cervical LNs	Well defined intra-parotid cyst No enh	Well defined collection Marginal enh Smudging of the overlying fat planes	Well defined Fat Density / Signal lesion No enh	Multiple intra-parotid LNs Central cystic component + marginal enh	Parotid tail Cystic + Solid enhancing component
No LNs	LNs	No LNs	Suppurative LNs	NO LNs	Ipsilateral cervical LNs	No LNs

Sjögren Syndrome

- Systemic autoimmune disorder
- Sex: Predominantly women.
- Age = 40–60 years.
- **Sicca syndrome** = Dry mouth + eyes + Skin
- Serologic evidence of autoantibodies
- Histologic evidence of salivary lymphocytic infiltration by parotid biopsy.

Radiological features:

Earliest stage SjS: Parotids may appear normal

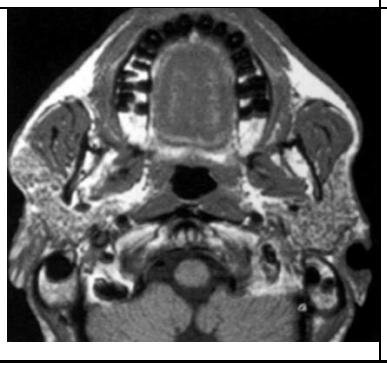
Intermediate stage SjS: Bilateral diffuse "Miliary pattern" of small cysts

Late stage SjS: bilateral larger cysts (parenchymal destruction) & solid masses (lymphocyte aggregates)

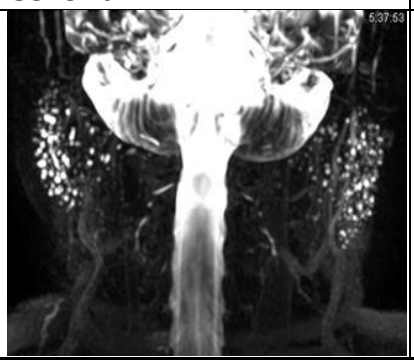
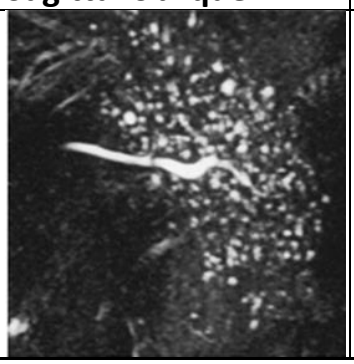
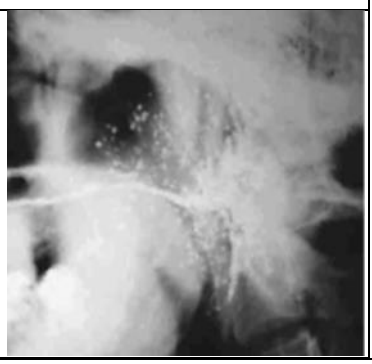
± Intraglandular calcifications

No Lymphadenopathy

NHL may arise from Sjögren's syndrome.

Miliary pattern	Cystic changes	Intraglandular calcifications
		

MR Sialography => Grape like appearance

Coronal MIP	Sagittal oblique MIP	
		

Lymphoepithelial Cysts

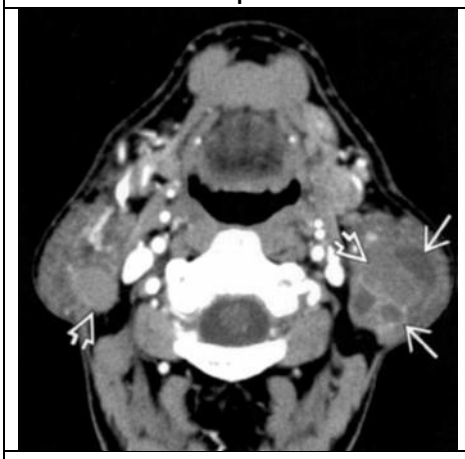
HIV – AIDS patients

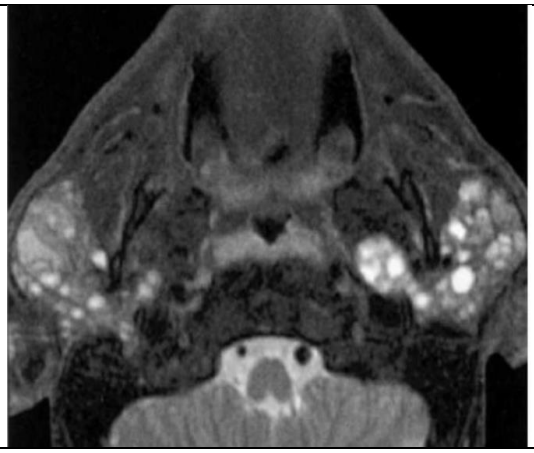
Triad of:

1) Multiple bilateral parotid cystic + solid lesions
2) Reactive adenoid, tonsils hyperplasia
3) Cervical reactive adenopathy

Radiological features:

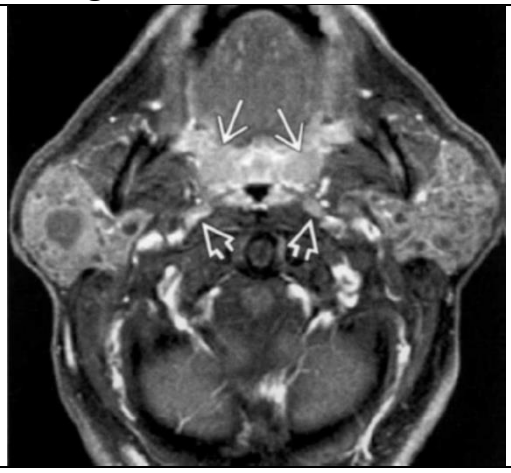
Bilateral intra-parotid solid and cystic lesions





Enlarged Adenoid

Enlarged tonsils

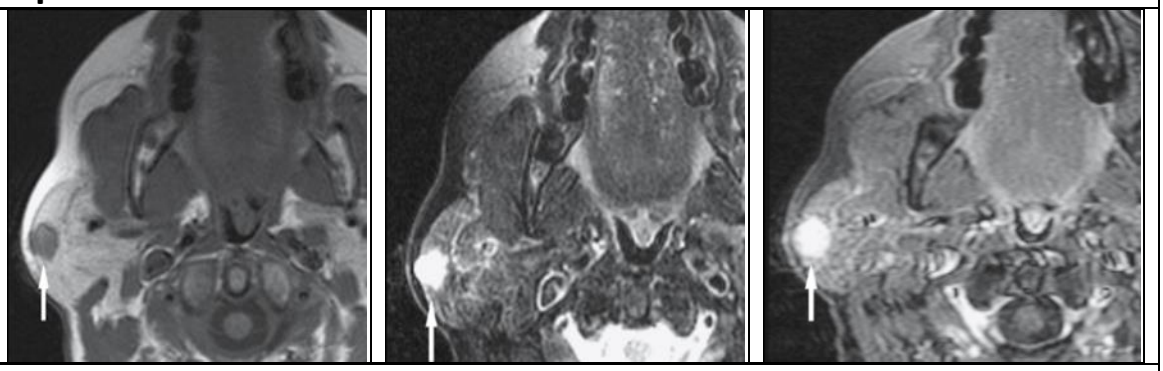


C- Parotid Solid Lesions			
Pleomorphic Adenoma	**WARTHIN TUMOR**	**NHL**	**Malignant Salivary Gland Tumors**
(Benign mixed Tumor): Most common Age: 40 – 50y Sex: F > M Solitary unilateral	2nd most common Age = 60 years M> F = 3:1 Unilateral or bilateral Parotid tail	M > F Middle & adults > Pediatric	Adenoid cystic carcinoma Mucoepidermoid ca. Adenocarcinoma Acinic cell carcinoma
Well defined lobulated lesion	Well defined lesion. Solid + Cystic component	Well defined homogenous mass	Ill defined lesion
Homogenous enh	Heterogeneous enh	Homogenous enh	Heterogeneous enh
No deep invasion No perineural spread			Deep invasion Perineural spread
No LNs	No LNs	+/- Multiple groups of LNs	Ipsilateral LNs

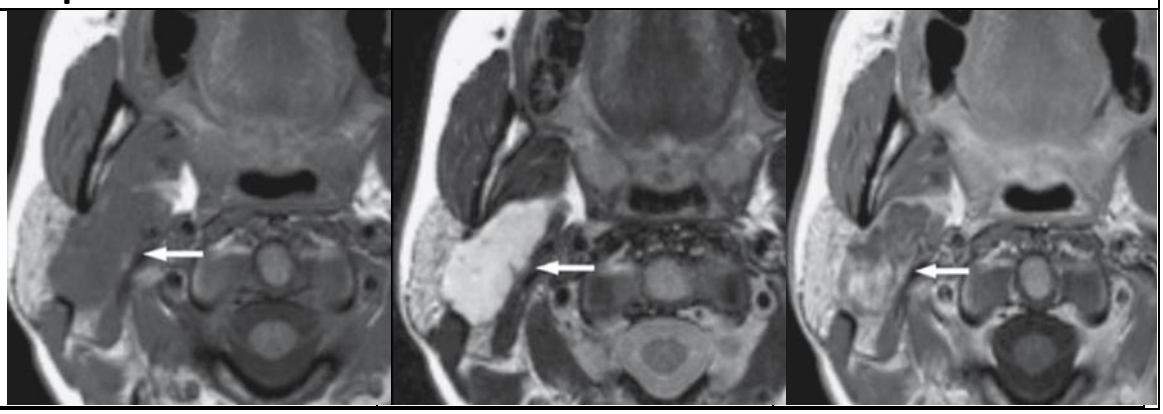
1) Pleomorphic Adenoma = Benign Mixed Tumor

1st common salivary gland tumor Age = 40 – 50y Sex: F > M = 2:1	**Distribution:** 85% in parotid glands 8% in submandibular glands 0.5-1% in sublingual glands 6.5% in minor salivary glands on mucosal surface of Soft palate > > oropharyngeal mucosal space> nasopharyngeal mucosal space
Radiological features: Solitary unilateral Well defined lobulated lesion Homogenous enhancement +/- Calcifications	

Superficial lobe



Deep Lobe

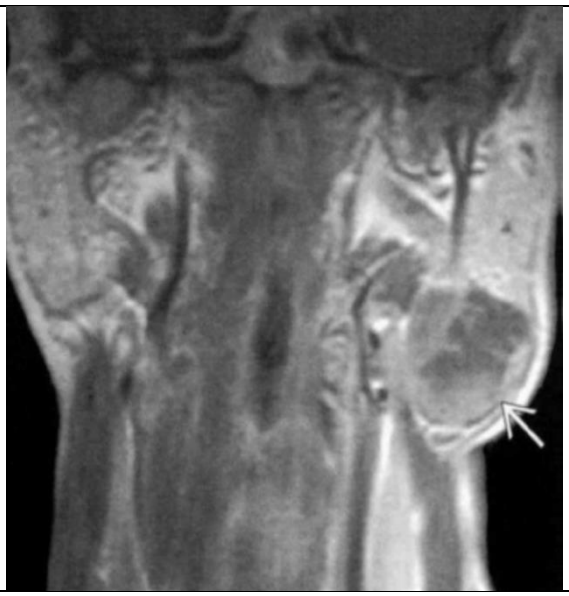


2) Warthin Tumor

2^{nd} most common benign tumor
Age = 60y
Sex = M > F = 3:1

Radiological Features:

Unilateral or bilateral
Parotid tail lesion
Well defined lesion
Cystic component
No calcification
Heterogeneous enhancement

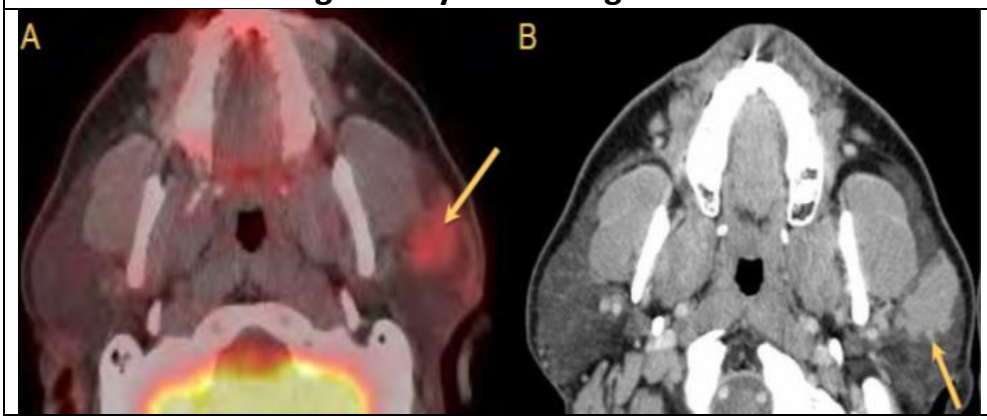


3) Parotid NHL

<u>Extra-nodal NHL in H&N:</u> Waldeyer's ring Sinonasal cavity Salivary glands Orbit Thyroid gland.	CT: Homogenous density T1: Low signal T2: Intermediate signal +C: Mild homogenous enhancement DWI: Restricted ADC: low value PET-CT: Avid FDG uptake
<u>Radiological Features:</u>	

Diffuse homogenously enhancing lesion replacing parotid gland

Well defined homogenously enhancing lesion

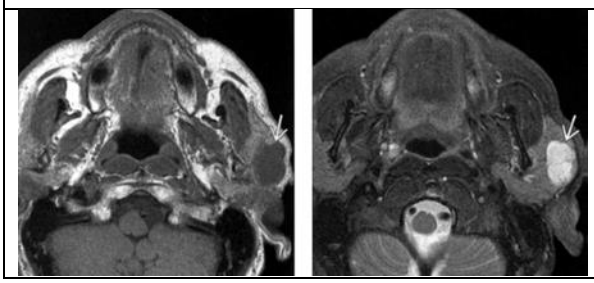
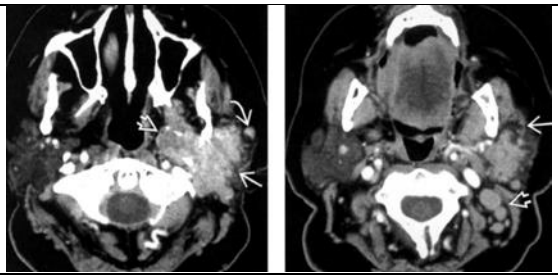


4) Malignant Salivary Gland Tumor

Adenoid cystic carcinoma Mucoepidermoid ca. Adenocarcinoma Acinic cell carcinoma	**<u>Radiological features:</u>** Low grade tumors: well defined High grade tumors: Ill defined Heterogeneous enhancement Deep invasion Perineural spread (CN 7) Ipsilateral LNs

<u>TNM Staging:</u>

T1: Tumor :≤ 2 cm without extraparenchymal extension
T2: Tumor 2-4 cm without extraparenchymal extension
T3: Tumor 4-6 cm with extraparenchymal extension
T4: Tumor> 6 cm or invades adjacent structures
Mandible, skull base, deep spaces of suprahyoid neck

Low grade **Well defined lesion**	**High grade** **Ill defined lesion**
	

IV. Masticator Space

Anatomy:

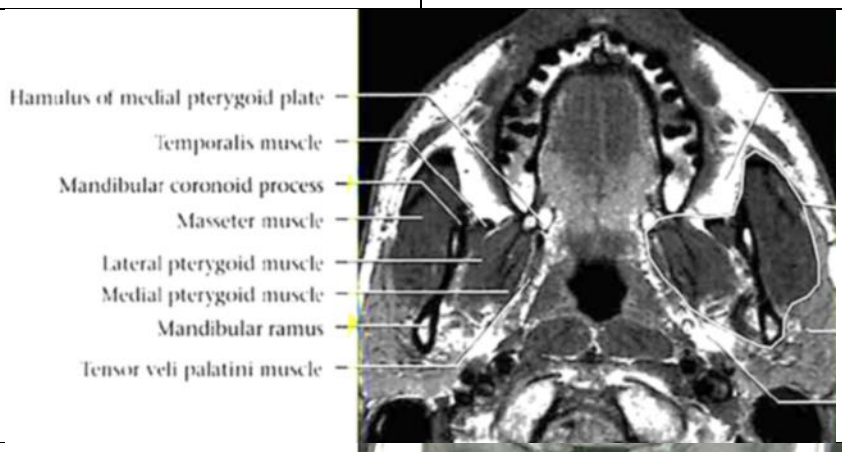
2 Compartments:

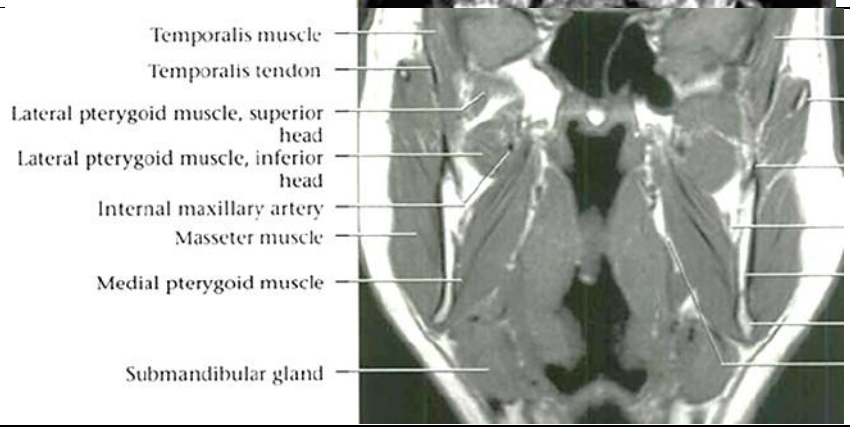
Supra-zygomatic MS = Temporal fossa :

- Temporalis muscle

Infra-zygomatic MS = Infra-temporal fossa:

- Masseter
- Medial & lateral pterygoids
- CNV3
- Ramus of mandible

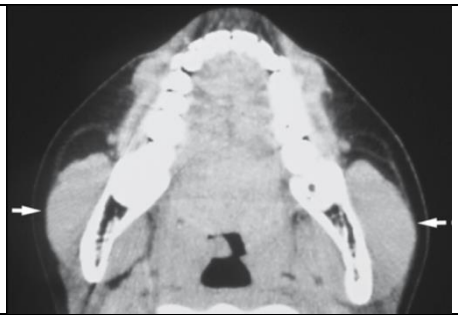




A- Masticator Space Diffuse Enlargement

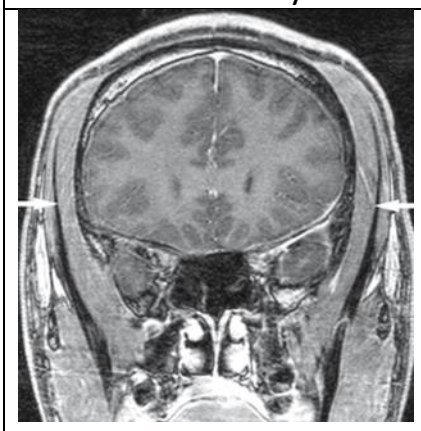
1) Masseteric hypertrophy

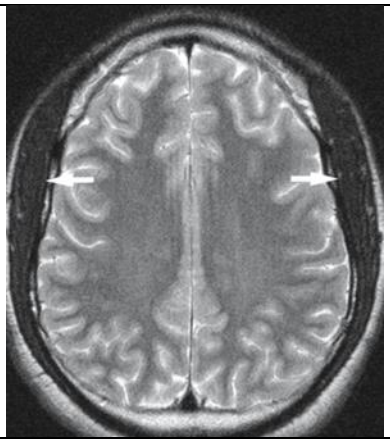
Diffuse homogenous enlargement of one or both masseter muscles.
Normal signal / attenuation
No focal solid or cystic lesions



2) Temporalis hypertrophy

Diffuse homogenous enlargement of both temporalis muscles
Normal signal / attenuation
No focal solid or cystic lesions

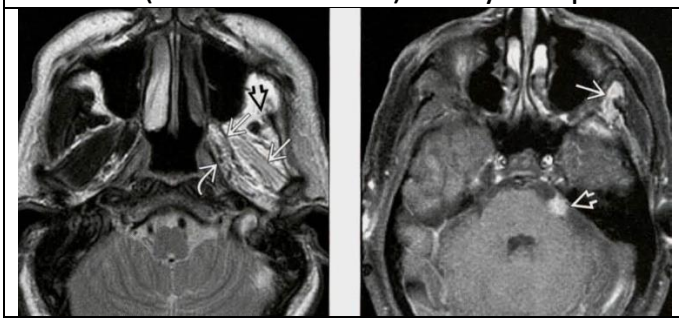




B- Masticator Space Diffuse Atrophy

V3 Denervation Atrophy

Acute (<1 month): Muscles slightly enlarged with edema + enhancement
Subacute (<12-20 months): Fatty replacement & atrophy begins
Chronic (> 12-20 months): Fatty atrophic muscles + volume loss



B- Benign Soft Tissue Lesions

Mandibular Schwannoma

Benign tumor arising from Schwann cells of the nerve sheath.

Age: Middle age Sex: F > M Multiple => NF-II	**Location:** Proximal V3 > > Distal V3 in MS > Inferior alveolar branch of V3

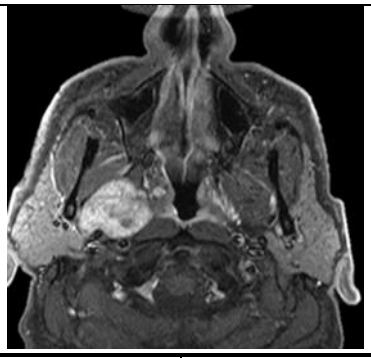
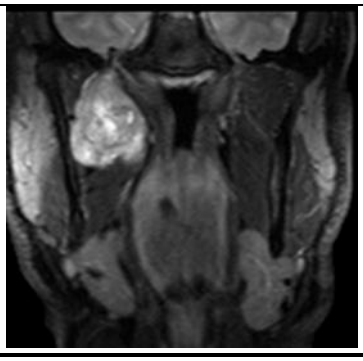
Radiological Features:

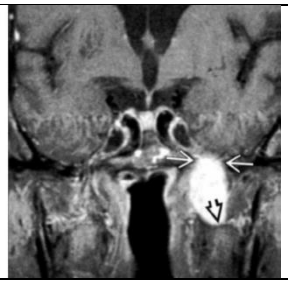
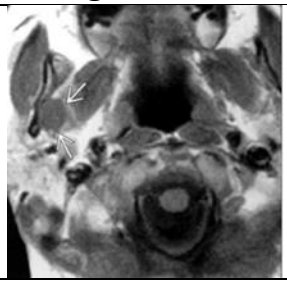
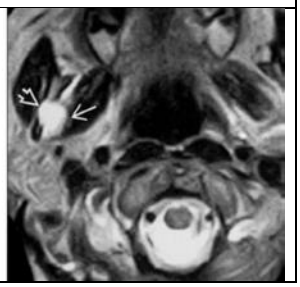
Well defined lesion

T1: Low signal.

T2: High signal + Intratumoral cysts

+C: Mild homogenous enhancement + Nonenhancing Intratumoral cysts

T2 FS: High signal	T1+C FS: Mild Enhancement	
		

Enlarged F. Ovale		Enlarged Mandibular Foramen	
			

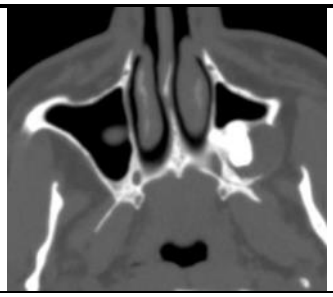
D- Destructive Lesions

Odontogenic Osteomyelitis	**Rhabdomyosarcoma RMS**	**Osteosarcoma OS**	**Ewing Sarcoma ES**	**Chondrosarcoma**	**MFH / PUS**
Dental caries / extraction	1st common soft tissue sarcoma in pediatric	1st most common 1ry bone tumor in pediatric	2nd most common 1ry bone tumor in pediatric		Most common soft tissue sarcoma in adults
DM/Imunocompromised	**Age: Children & Adolescents Sex: M > F**			**Age: Adults > 30 y Sex: M > F**	
Peri-apical lucency Ill defined osteolytic lesion Cortical disruption Periosteal reaction Masticator space soft-tissue inflammatory changes Smudging of fat planes Skin/Fascial thickening	**Ill defined Soft tissue lesion + Infiltrative medullary lesion Cortical destruction + Periosteal reaction Deep soft tissue Invasion +/- Intracranial extension +/- Perineural spread (V3)**				
	Non-specific	Ossified / Calcified matrix Periosteal reaction (Sunray – Codman triangle)	No osteoid or chondroid matrix Periosteal reaction (Laminated = Onion skin)	Chondroid matrix: Rings & arcs calcification T2: very High signal	Non-specific

E- Mandibular Cytsic Lesions

Dentigerous Cyst

- 2nd most common odontogenic cysts.
- Mandibular 3rd molar (most common)
- Maxillary 3rd molar (2nd most common
- Centered on an impacted or unerupted tooth

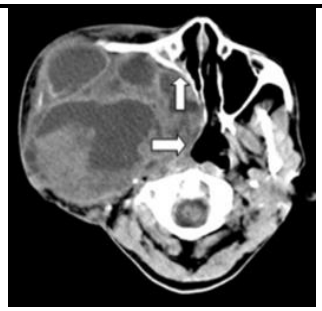
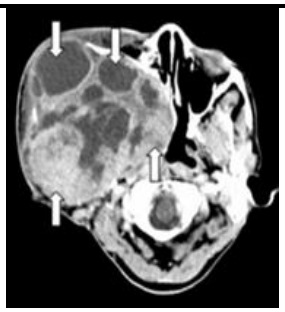


Odontogenic keratocyst

- Cystic benign tumor
- associated with an impacted tooth
- Multiple KCOTs is associated with Gorlin-Goltz syndrome

Ameloblastoma

- Locally aggressive tumor
- 3rd molar tooth
- Mandible (80%)
- Maxilla (20%
- Associated with unerupted tooth
- Multilocular
- Soap bubble appearance
- Mixed solid and cystic lesion

Rhabdomyosarcoma

Most common pediatric soft tissue sarcoma

Age: Children (70-80% <10 y)
Sex: M > F
Location: H&N 40%

Primary locations in H&N:

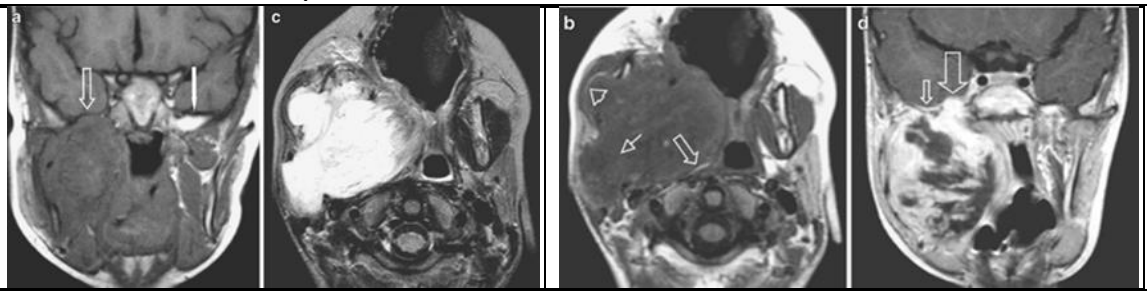
- Parameningeal (PM) 50%
- Nonparameningeal (NPM) 25%
- Orbital (ORB) 25%

Pathology:

- Embryonal
- Alveolar
- Pleomorphic

Radiological Features:

Aggressive ill defined soft tissue lesion
T1: Low signal
T2: Heterogeneous high signal
+C: heterogeneously enhancement
Bone destruction
Invasion of adjacent fascial planes/spaces
± Intracranial extension
± Perineural tumor spread



MFH / PUS

Malignant Fibrous Histocytoma (MFH) = Fibrosarcoma =
Pleomorphic Undifferentiated Sarcoma (PUS)

Most common soft tissue sarcoma in adults.

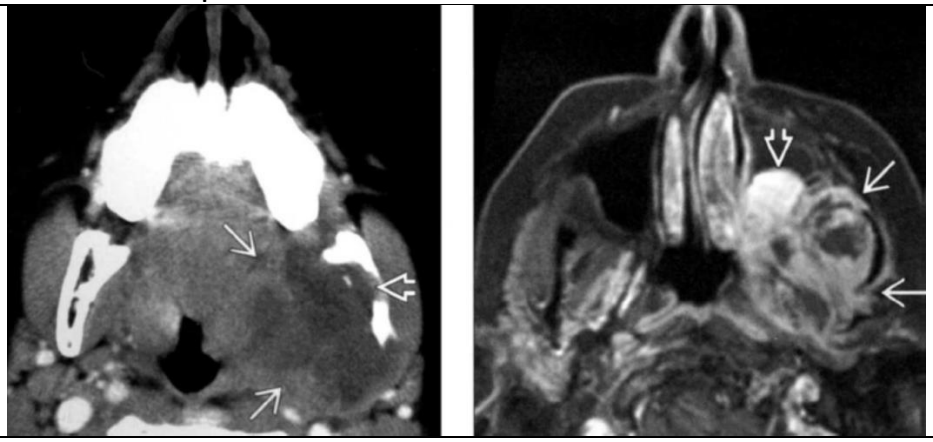
Age > 30 y
Sex: M > F

Predisposing factors:

- Radiotherapy
- Paget disease

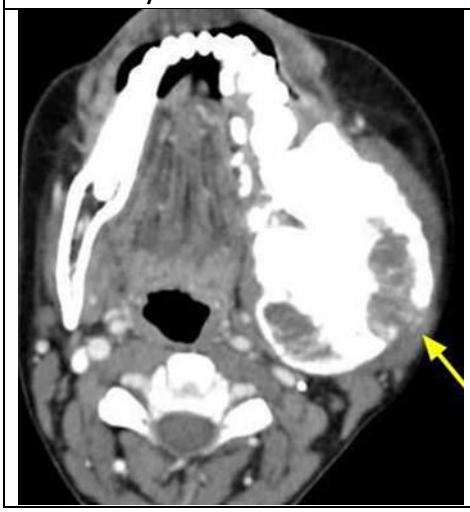
Radiological Features:

Aggressive ill defined soft tissue lesion
T1: Low signal
T2: Heterogeneous high signal (Hemorrhage + Necrosis)
+C: Heterogeneously enhancement
Bone destruction
Invasion of adjacent fascial planes/spaces
± Intracranial extension
± Perineural tumor spread



Osteosarcoma

1st common 1ry bone tumor in childhood.

Primary Osteosarcoma:	**Secondary Osteosarcoma:**
Age: Children & Adolescents (75% < 20 y) Sex: M > F	Age: Elderly 2ry to: Paget - Radiotherapy
Location: Metaphysis of long bones. Most common sites: Distal femur (40%) Proximal Tibia (16%) Humerus (15%) Less common sites: Mandible Maxilla Vertebrae	**Types:** Intra-Meduallry (80%) Conventional OS Telengiectatic OS Low grade OS Surface OS (10-15%) Paraosteal Periosteal Intracortical Extra-skeletal OS
Radiological features: Ill defined lesion Medullary infiltration Wide zone of transition Cortical destruction Periosteal reaction (Sunray – Codman triangle) Ossified / Calcified tumor matrix	T1: Non-mineralized component=>Inter Ossified component => Low T2: Non-mineralized component => High Ossified component => Low +C: Heterogeneous enhancement
	

Ewing Sarcoma

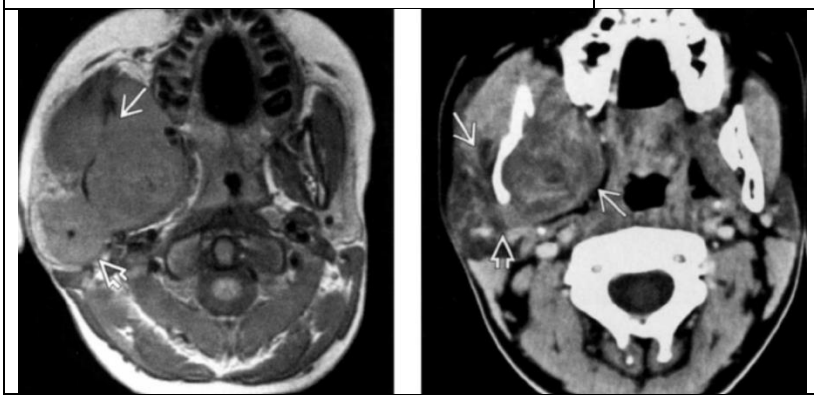
Ewing Sarcoma Family of Tumors (ESFT) = Small round blue cell tumors:

1. Ewing sarcoma
2. Peripheral primitive neuroectodermal tumor (pPNET)
3. Askin tumor
4. Neurepitheloma

2nd common 1ry bone tumor in childhood after OS.

Age: Children & Adolescents (95% < 25 y)
Sex: M > F

Location:	**Location within long bones:**
Long bones (50-60%) Femur – Tibia – Humerus Flat bones (40%) Pelvis – Scapula – Ribs – Mandible	Mid-diaphyseal (33%) Meta-diaphyseal (44%) Metaphysis (15%)
Radiological features: Ill defined lesion Medullary infiltration Wide zone of transition Cortical destruction Periosteal reaction (Laminated = Onion skin) No osteoid or chondroid matrix	T1: Low T2: Heterogeneous high +C: Heterogeneous enhancement

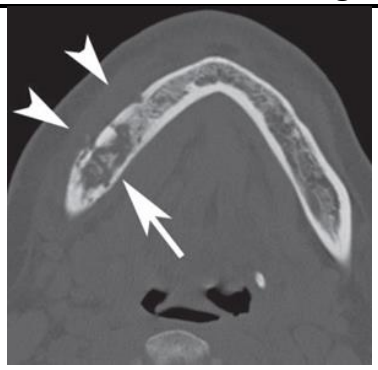


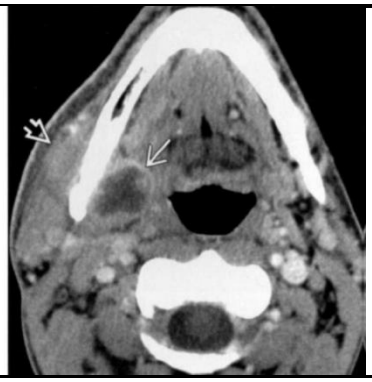
Chondrosarcoma

Malignant cartilaginous bone tumor Age = 30 -45 y Sex: M > F	**<u>Chondrosarcoma Grading:</u>** Low – Intermediate – High
Primary Chondrosarcoma	**Secondary Chondrosarcoma**
Conventional intramedullary chondrosarcoma Juxtacortical chondrosarcoma Myxoid chondrosarcoma Mesenchymal chondrosarcoma Extraskeletal chondrosarcoma Dedifferentiated chondrosarcoma	Arising from pre-existing cartilagenous lesions • Enchondroma • Osteochondroma
<u>Location:</u> Long bones: 45% Femur: 20-35% Tibia: 5% Proximal humerus: 10-20%	Pelvis: 25% Scapula – Sternum – Ribs: 15% Spine: 7% Craniofacial: 2%
<u>Radiological features:</u> Ill defined lesion Medullary infiltration Wide zone of transition Endosteal scalloping (>2/3 of cortical thickness) Cortical destruction Chondroid matrix: (Rings – Arcs calcification)	T1: Low signal **T2: Very high signal** +C: Moderate – Intense heterogeneous enhancement

Odontogenic Osteomyelitis

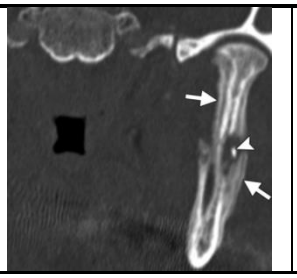
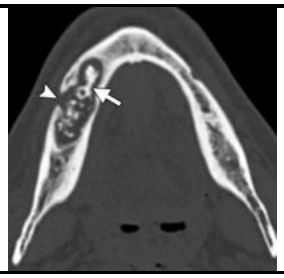
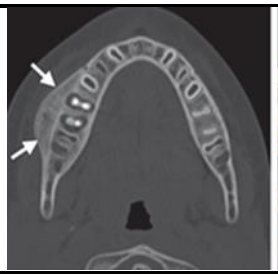
Causes:	**Risk factors:**
Dental caries Dental extractions Dental or mandibular fractures Osteoradionecrosis Hematogenous spread of infection.	Diabetes mellitus Alcoholism Malnutrition Sickle cell disease Collagen vascular diseases Radiation therapy
Acute Osteomyelitis: Peri-apical lucency Ill defined osteolytic lesion Cortical disruption Periosteal reaction Soft-tissue inflammatory changes Smudging of fat planes Skin / Fascial thickening	**Masticator Abscess:** Central necrosis Marginal enhancement





Chronic Osteomyelitis:

Sclerotic sequestrum
Surrounding low-attenuation zone
Sinus tract through the buccal lingual cortex.
Periosteal new bone formation “Lamellated = onion skinning”

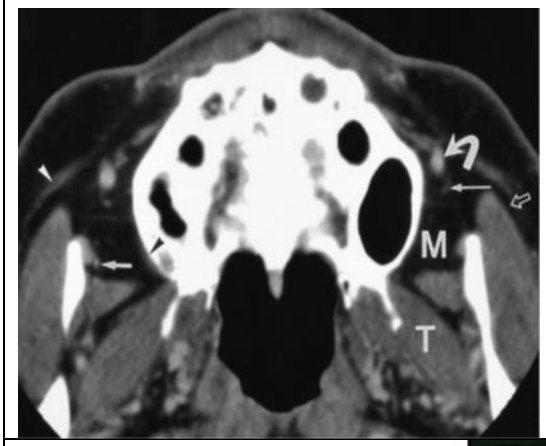
V. Buccal Space

Anatomy

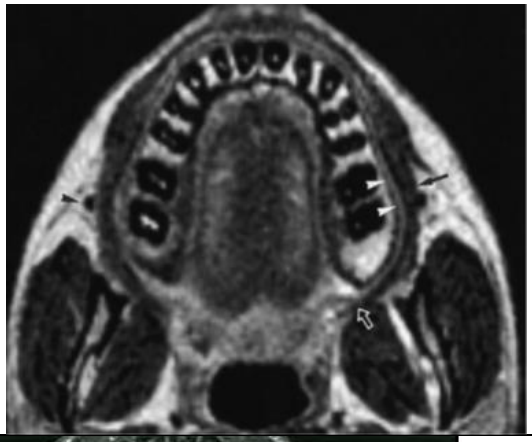
Content:

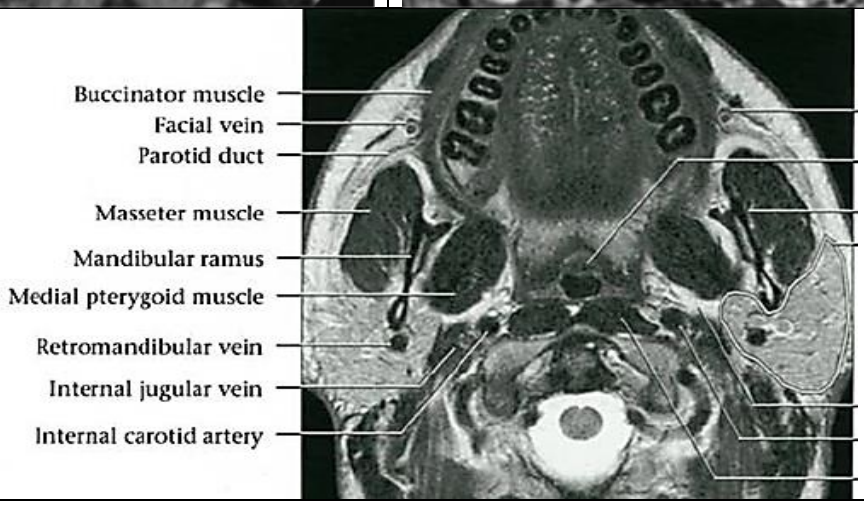
- Fat
- Buccinator muscle
- Fascial artery & vein
- Parotid duct

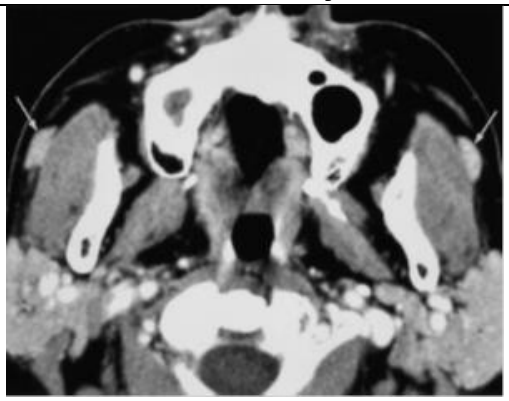
Fascial vein



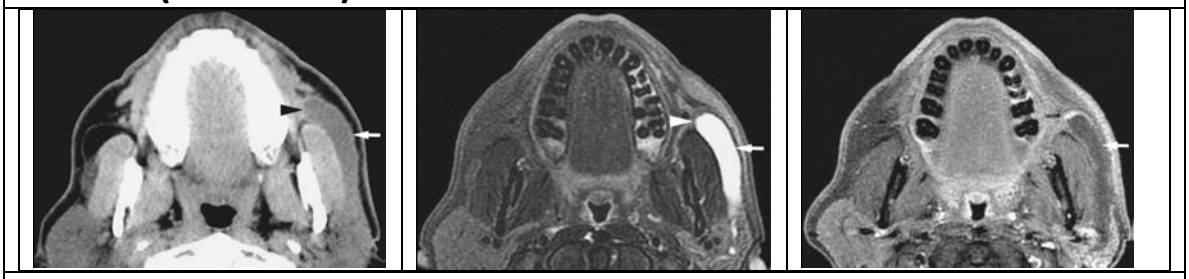
Buccinator muscle



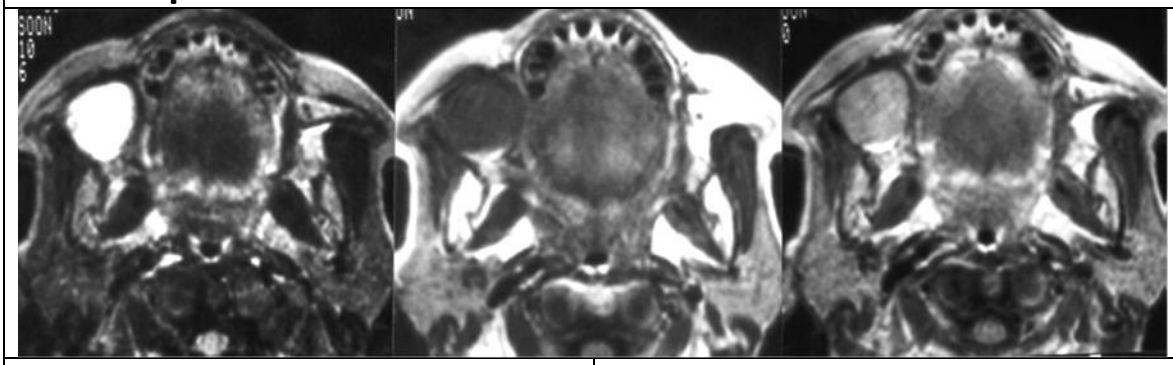


Parotid (Stensen's) duct stone	Bilateral Accessory Parotid
	

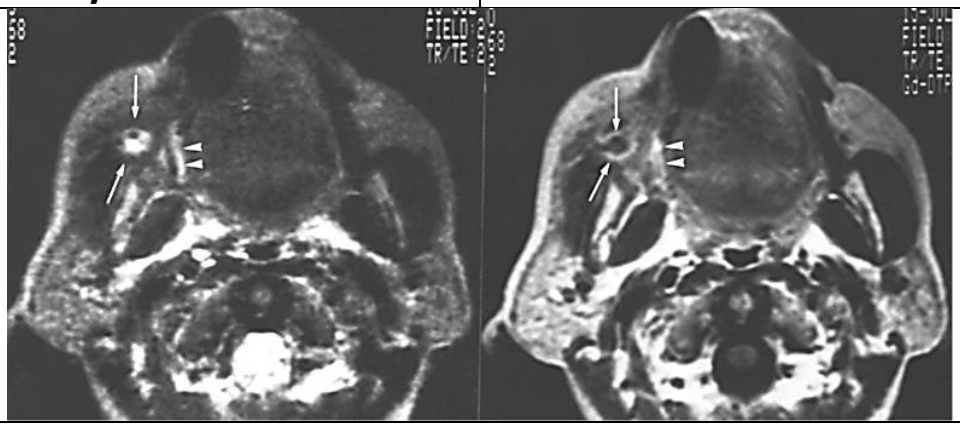
Parotid (Stensen's) duct Dilatation



Pleomorphic Adenoma



Adenoid Cystic Carcinoma



VI. Visceral Space

A. Larynx & Hypopharynx

Anatomy

6 Cartilaginous Framework:

3 Single:
Epiglottis: Leaf like shape
Cricoid: Signet ring shape
Thyroid: open book shape

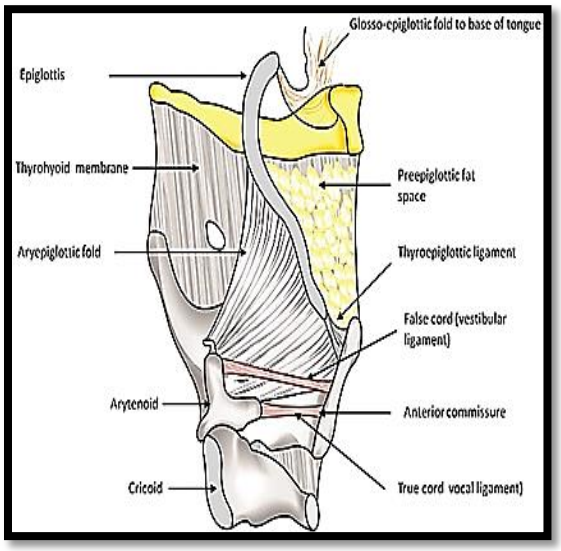
3 Pairs:
Arytenoid: pyramidal shape
Cornicular: sits on arytenoid
Cuniform: lateral to free margin of aryepiglottic fold

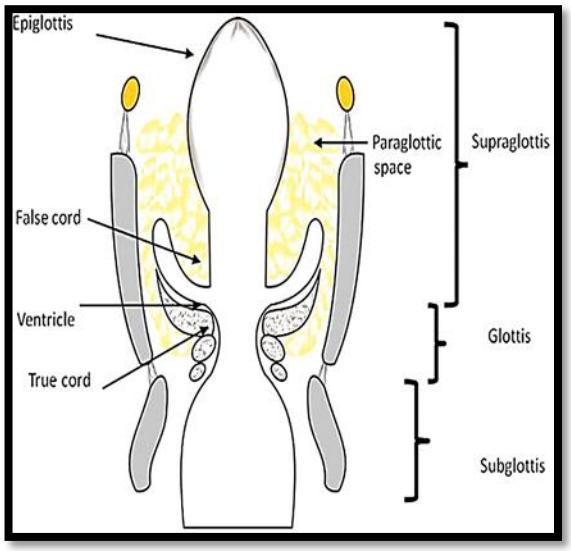
Larynx => 3 Subdivisions:

Supraglottic
Glottic
Infraglottic

Hypopharynx => 3 Subdivisions:

Pyriform sinus
Post-cricoid
Posterior Wall

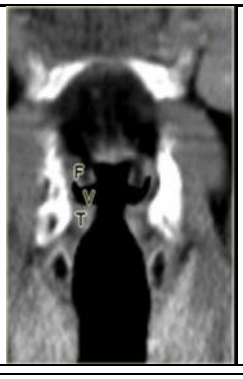




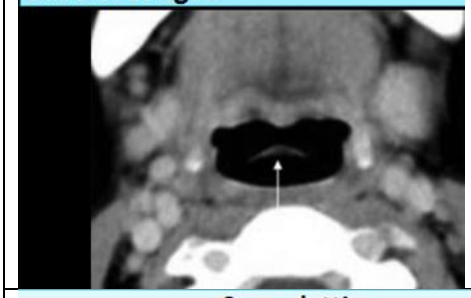
Mid-Sagittal:
Epiglottis
Valecullae
=> Air
Pre-epiglottic
=> Fat

Coronal:

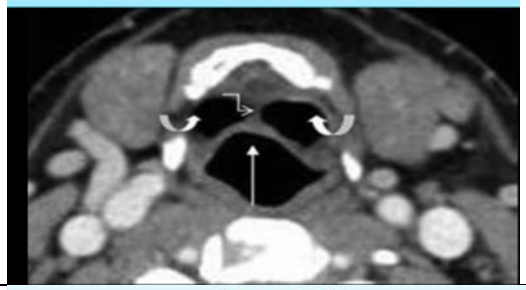
- FVC
- Laryngeal ventricle
- TVC



Supraglottis:
Tip of Epiglottis level
Base of tongue

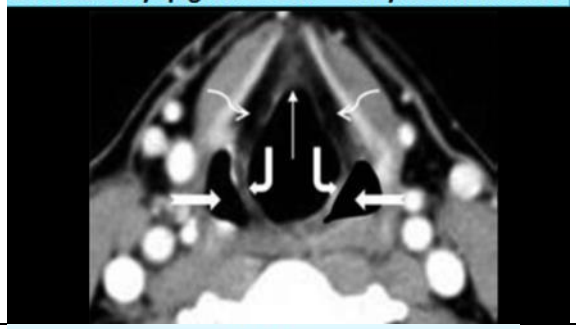


Supraglottis:
Hyoid bone level + Upper epiglottis
Midline Hyoepiglottic / Glossoepiglottic fold
2 lateral pharyngoepiglottic folds + 2 Valleculae



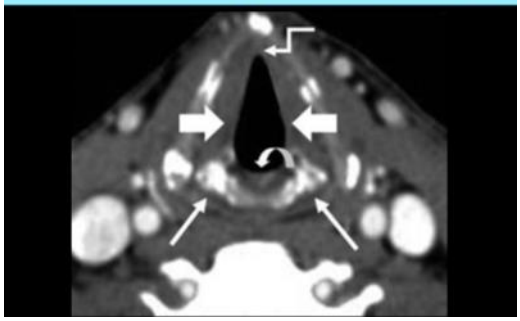
Supraglottis:
Hyoid bone level + Upper Epigllotis
Midline Preepiglottic space
2 lateral Aryepiglottic folds + 2 Pyriform Sinuses

Supraglottis:
Thyroid + Mid Epigllotis level
C-shaped Preepiglottic + Paraglottic space
2 lateral Aryepiglottic folds + 2 Pyriform Sinuses



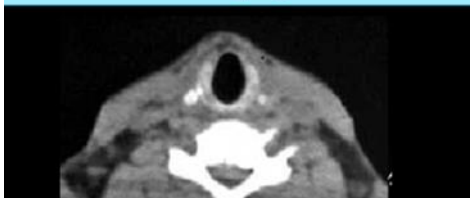
Supraglottis:
Tip of Arytenoid + Lower Epigllotis level
C-shaped Preepiglottic + Paraglottic space
2 Tip of Arytenoid => FVC

Glottis:
Crico-Arytenoid articulation Level
TVC + Anterior + Posterior Commissures



Subglottis:
½ Cricoid + ½ Thyroid
Inferior horns of thyroid =>
Recurrent laryngeal nerve

Subglottis:
Complete signet ring of Cricoid
Inferior horns of thyroid =>
Recurrent laryngeal nerve



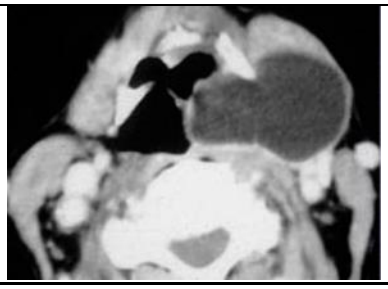
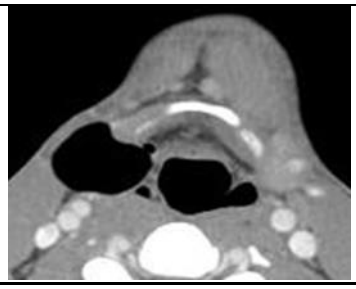
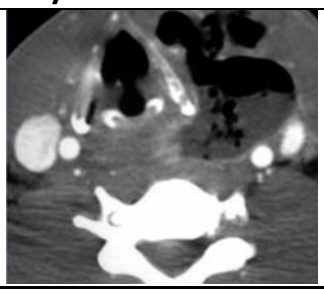
❖ Laryngocele

Types according to cause:

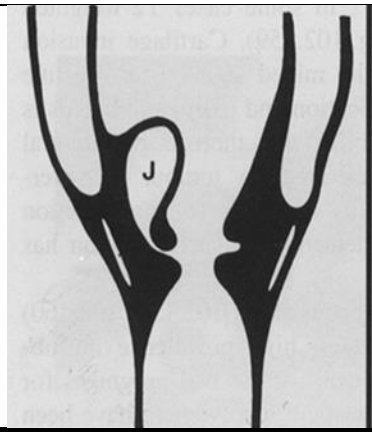
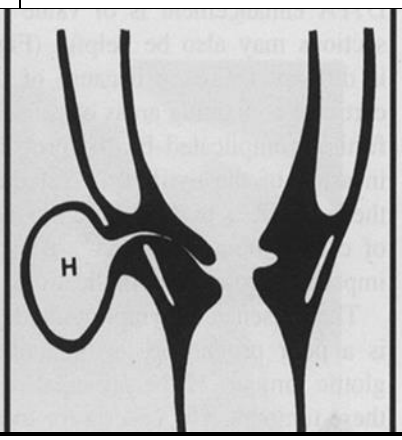
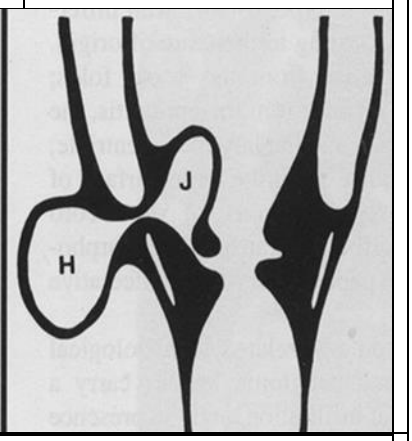
1ry: Due to increased intra-luminal air pressure

2ry: Due to obstruction of the ventricle with lower supraglottic or glottic tumor

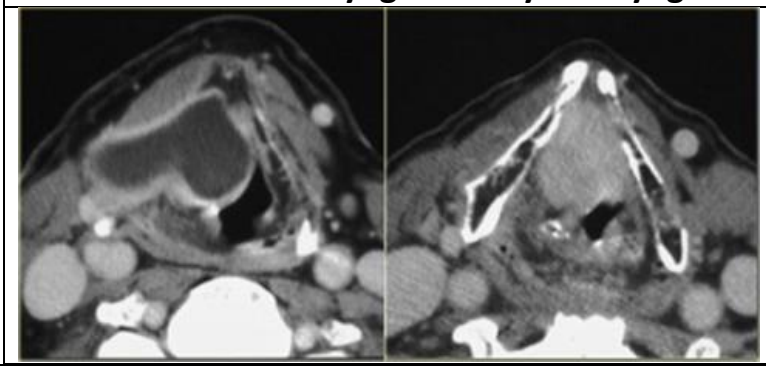
Types according to content:

Mixed Fluid Filled	Mixed Air Filled	Air/Fluid Level
		

Types according to location:

Internal	External	Mixed
		

Mixed Fluid filled Laryngocele 2ry to laryngeal tumor at ventricle



❖ Laryngeal Carcinoma

> 95% SCCa Risk factors – Smoking Age > 50 yrs Sex: M > F	**Subdivions:** Glottic – 60% Supraglottic – 30% Subglottic – 5%

TNM staging:

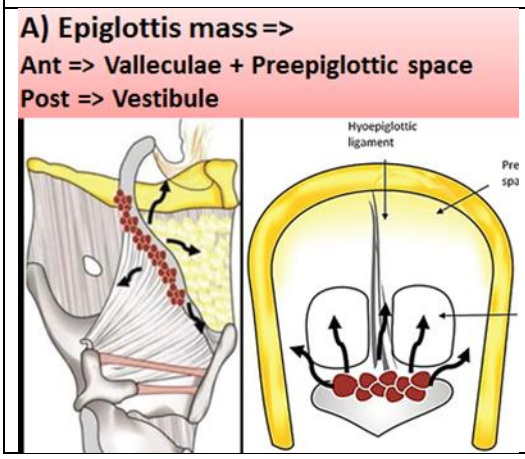
T1: limited to one subsite + Normal cord mobility
T2: more than one subsite + Impaired cord mobility (but no fixation)
T3: limited to larynx + Cord fixation
T4: extension into tissues beyond larynx.

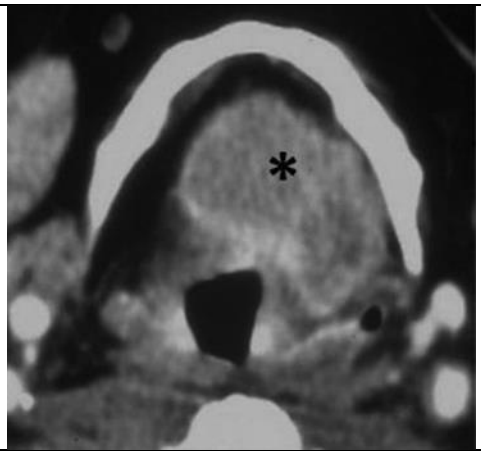
Cartilage Invasion:

CT: Sclerosis, erosion, lysis and the presence of extralaryngeal tumor
T1: Abnormal soft tissue intensity within the bright signal of the medullary fat of the cartilage.
T2 FS: High intra-cartilaginous signal
T1+C FS: intra-cartilaginous enhancement

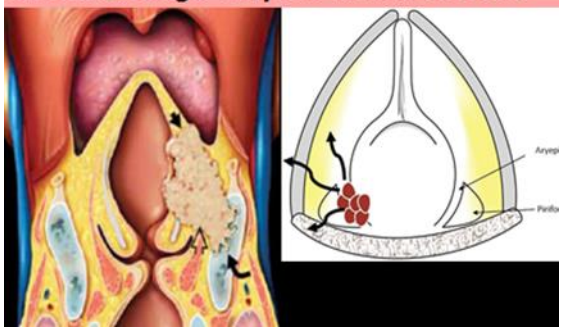
I. Supra-Glottic Carcinoma:

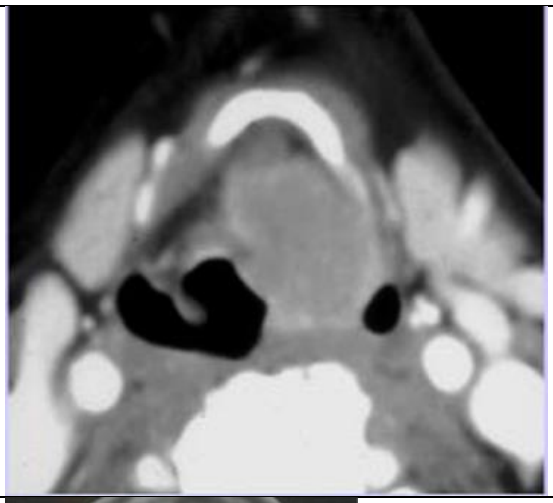
A. Epiglottis
B. Aryepiglottic folds
C. False cords



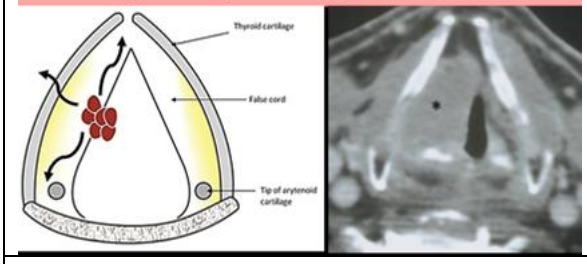


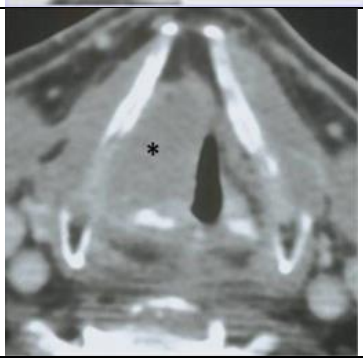
B) Aryepiglottic fold mass => Invading
Pre & Para-glottic fat space + Pyrifrom sinus
Cricoid cartilage + thyroid lamina sclerosis





C) FVC mass =>
Invading Paraglottic space

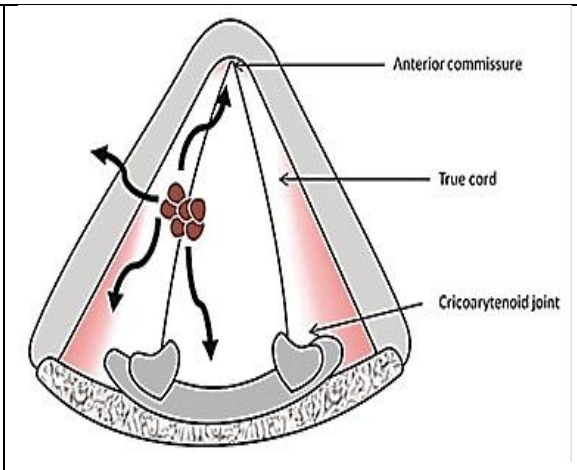




II. Glottic Carcinoma:

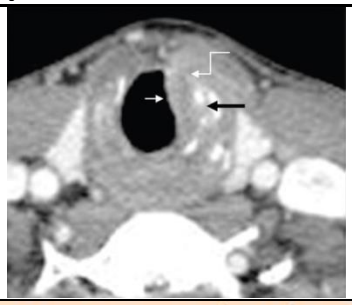
True vocal cord + Extension:

Anteriorly => Anterior commissure >1mm
Posteriorly => Arytenoid cartilage
Caudally => Infraglottis
Cranially => Supraglottis



III. Subglottic Carcinoma

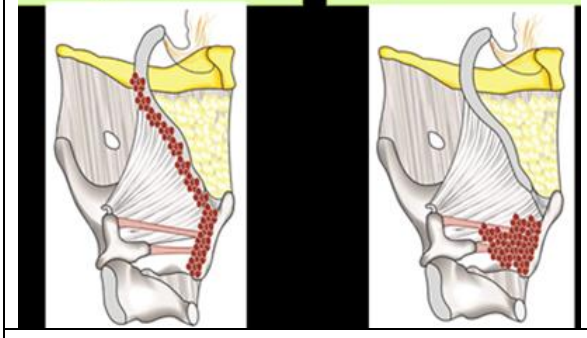
Anterior extension through cricothyroid membrane => Extralaryngeal spread



IV- Transglottic Carcinoma

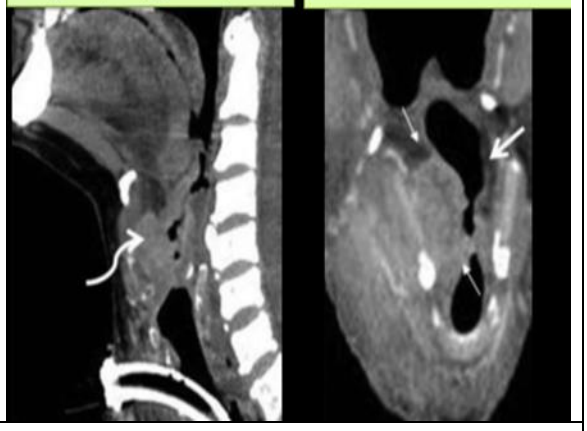
Supraglottic mass spanning the glottis and the subglottis

Glottis mass extending into supraglottis and subglottis



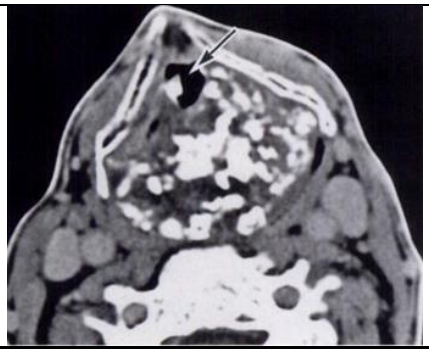
Transglottic mass spreading along the preepiglottic space

Transglottic mass spreading along the right paraglottic space

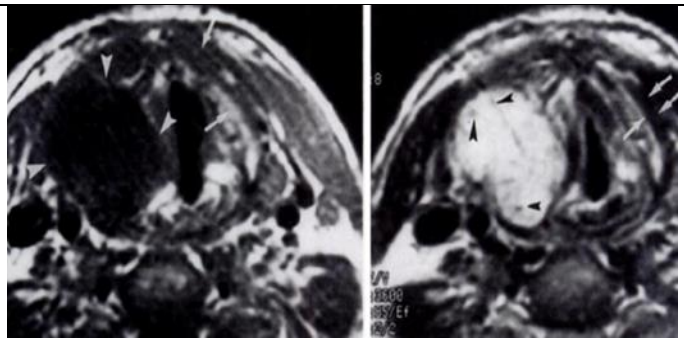


Laryngeal Cartilage Tumors

Chondroma



Chondrosarcoma



❖ Hypopharyngeal Carcinoma

Rare H&N tumor > 95% SCCa Age > 50 yrs Sex: M > F	**Subdivions:** Pyriform sinus – 60% Posterior pharyngeal wall Post cricoid

Risk factors:

- Smoking – Alcohol
- Posterior cricoid tumours may be more common in women (especially of northern Europe) with Plummer-Vinson syndrome

Clinical picture:

- Dysphagia
- Piriform sinus tumours have a tendency to cause referred pain to external acoustic meatus due to cross innervation with neurons of internal laryngeal nerve and auricular nerve, both branches of vagus nerve (CN X)

TNM staging:

T1: limited to one subsite + Tumor size <2cm

T2:

- Extends into adjacent subsite or area (larynx, oropharynx) and/or
- Tumour size between 2-4 cm in greatest dimension
- Clinically there must not be fixation of the hemilarynx

T3:

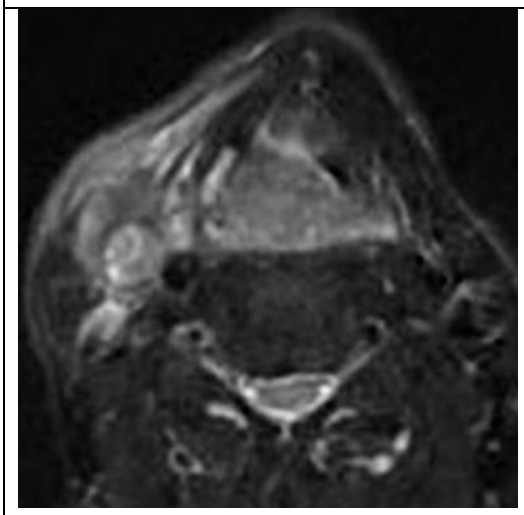
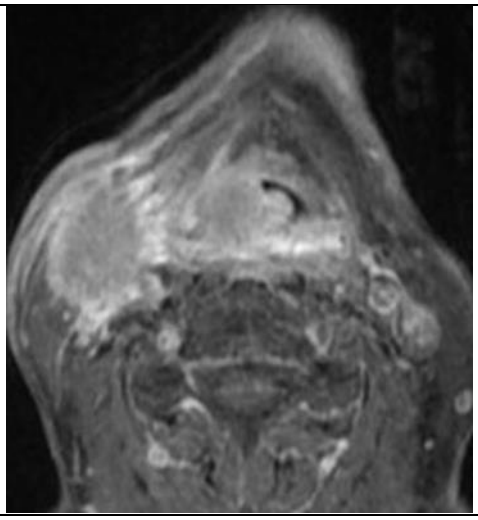
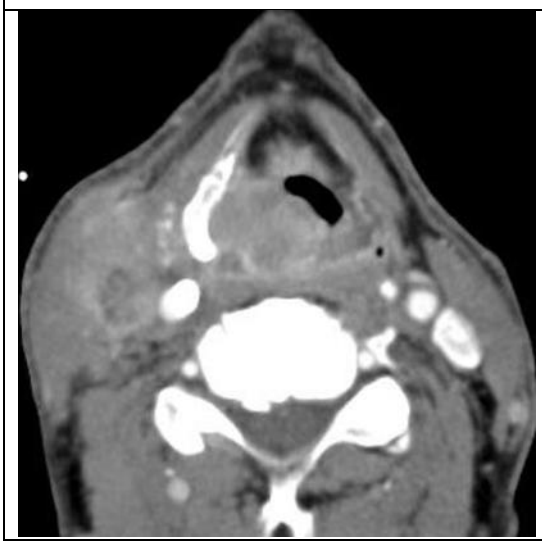
- Tumour size > 4 cm in greatest dimension OR
- Clinical fixation of hemilarynx

T4:

- T4a: direct invasion of one or more of the following:
  - Thyroid cartilage / cricoid cartilage
  - Hyoid bone
  - Thyroid gland
  - Oesophagus
  - Central compartment
- T4b: direct invasion of one or more of the following:
  - Mediastinal structures
  - Prevertebral fascia
  - Encases carotid artery

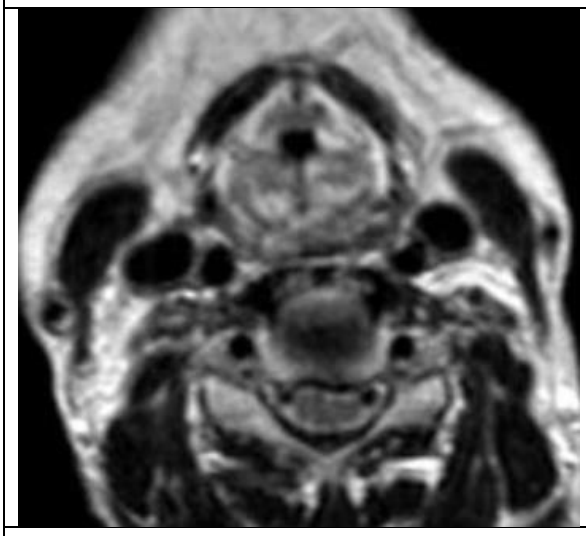
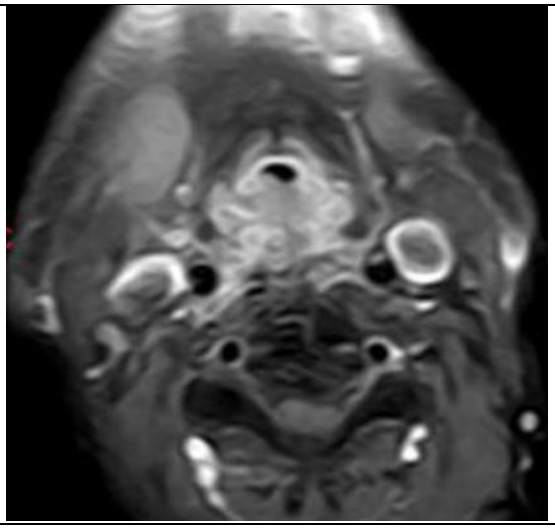
A) Pyriform Sinus Tumors

Anterior extension => Paraglottic fat space
Medial extension => Aryepiglottic fold => Supraglottic vestibule
Inferior extension => False and True vocal cords => Subglottic
Lateral extension => Thyroid cartilage invasion

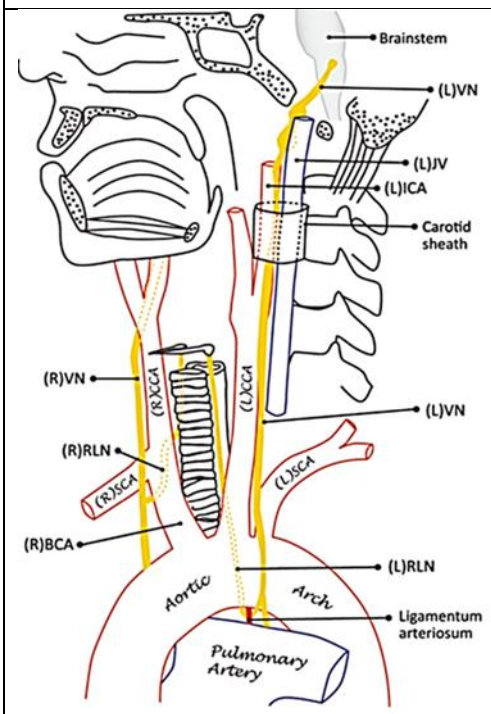
Axial T2 FS	Axial T1+C FS
	
Axial CT	Coronal CT
	

B) Post-cricoid Tumor

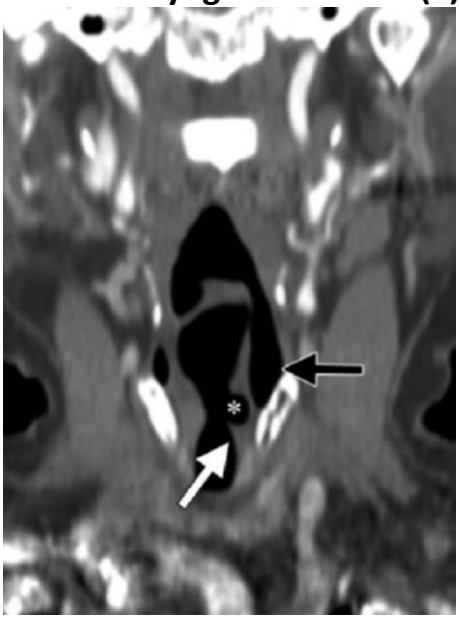
- ill defined soft tissue mass is seen occupying the prevertebral region at level of C5-C6
- Anterior extension => Cricoid infiltration
- Lateral extension => Parapharyngeal fat infiltration

Axial T2	Axial T1+C FS
	
Sagittal T2	Sagittal T1+C

❖ Vocal Cord Paralysis

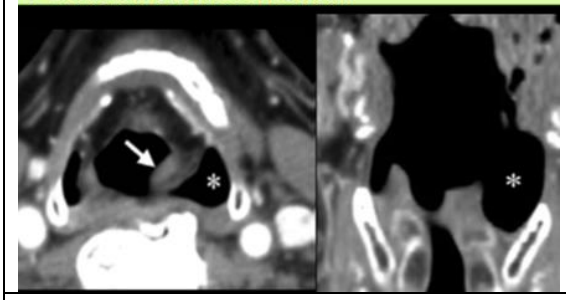


Dilated piriform fossa (black arrow)
Dilated laryngeal ventricle (*)

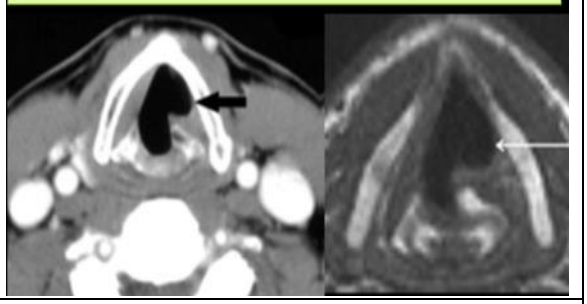


3 Reliable signs:

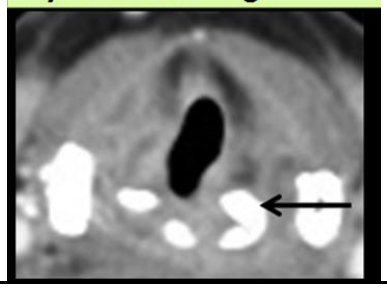
Medial Deviation + Thickening Of Aryepiglottic Fold + Dilated Piriform Sinus



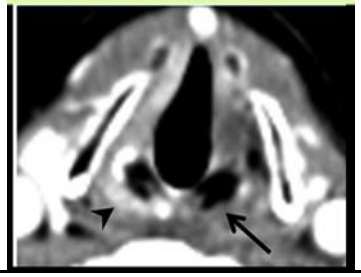
Dilated Laryngeal Ventricle



Anteromedial deviation of Arytenoid Cartilage

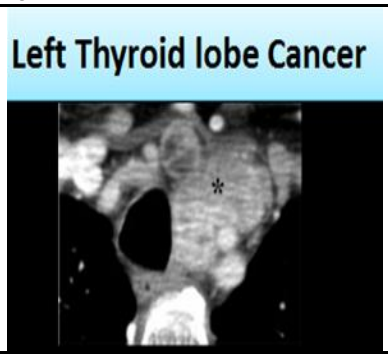


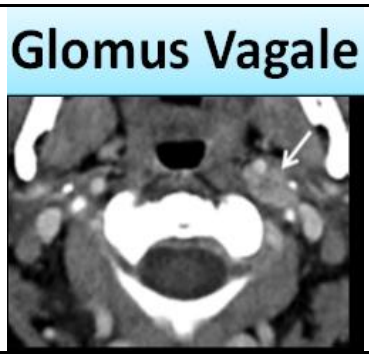
Fatty Atrophy Of Posterior Cricoarytenoid Muscle

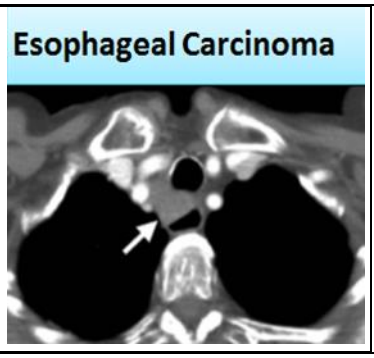


Fatty Atrophy Of Thyroarytenoid Muscle

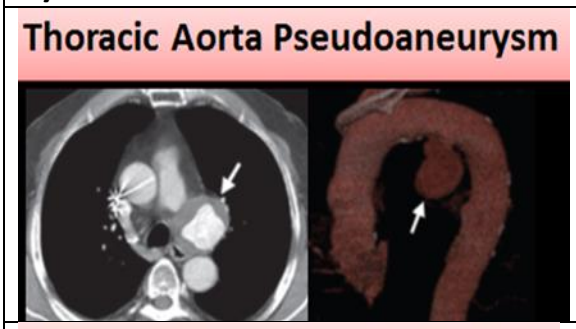
A) Cervical Causes:

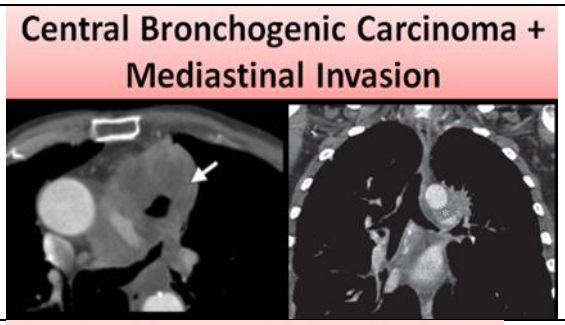


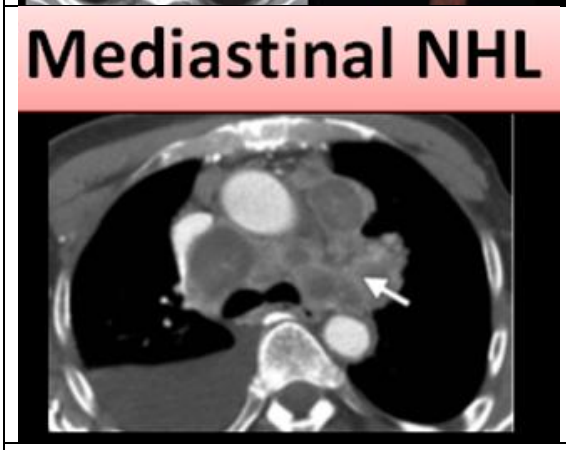


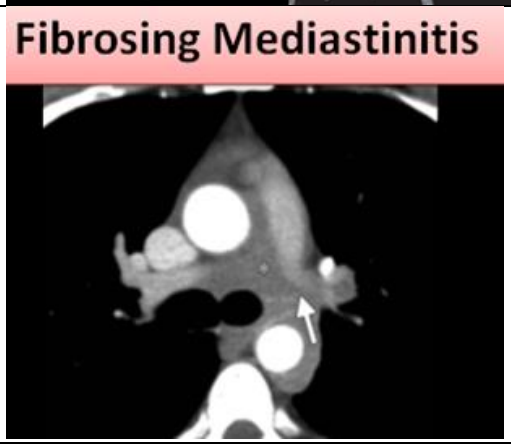


B) Mediastinal Causes



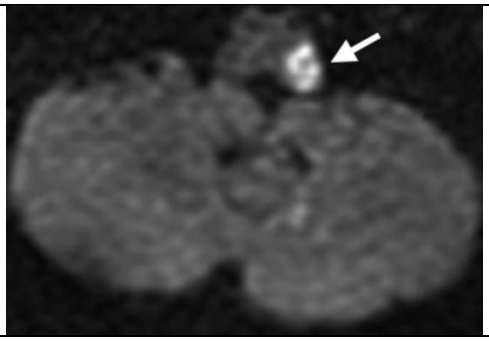






C) Central Causes:

- Infarction
- Demylinating disease
- Brain stem tumor



VI. Visceral Space

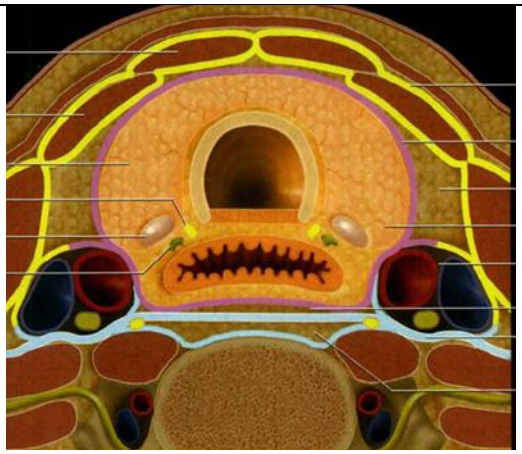
B. Thyroid Gland

Anatomy

Visceral Space Content:

Larynx & Hypopharynx
Thyroid gland & Parathyroid glands
Cervical trachea & esophagus
Recurrent laryngeal nerve: in tracheoesophageal groove
Lymph nodes (level VI group)

- Paratracheal LN group
- Prelaryngeal LN group
- Pretracheal LN group



Thyroid Gland:

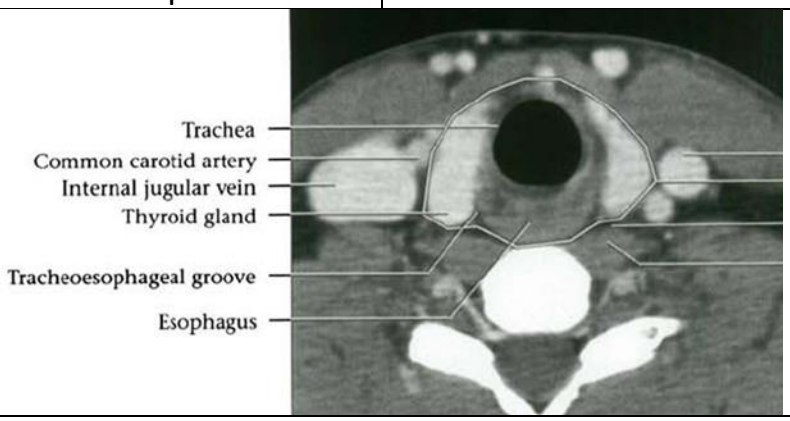
Butterfly or H-shaped
Composed of = 2 lobes + isthmus.

Normal measurements:

- Length: 4-7 cm
- Depth: <2 cm
- Isthmus <0.5 cm deep

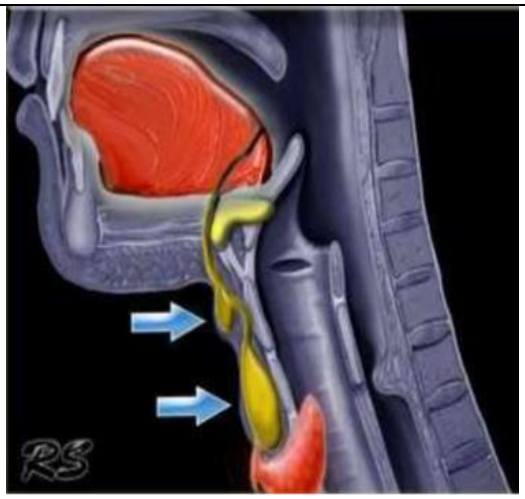
Lymphatic drainage

Peri-thyroid LNs
Prelaryngeal, Pretracheal and paratracheal LNs (level 6)
Spinal accessory LNs (Level 5)
Superior mediastinal LNs (Level 7)



❖ Thyroglossal Duct Cyst

Congenital neck cyst
Present during childhood



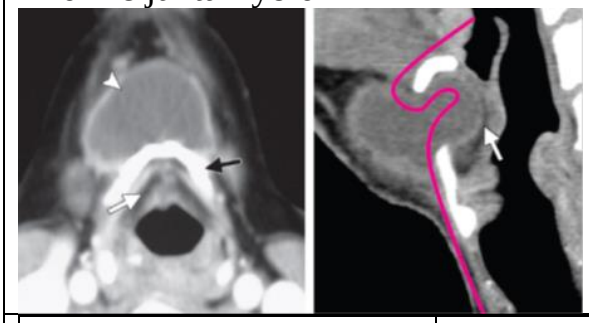
Thyroglossal duct
runs from the base of tongue at the foramen caecum to the thyroid gland

Location:
65% Infrahyoidal
20% suprahyoidal
15% juxtahyoid
2% Lingual
Rare: Lateral neck

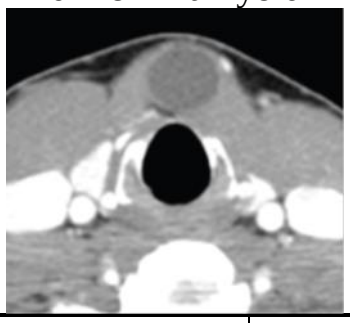
Radiological Features:
Midline / Para-midline
Well defined cyst

T1: High signal due to high proteinaceous content
T2: High signal
+C: No enhancement
+/- thin peripheral enhancement

Midline juxta-hyoid

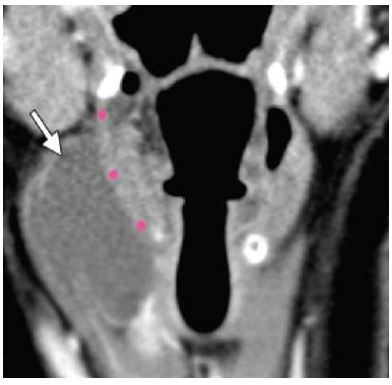


Midline infra-hyoid



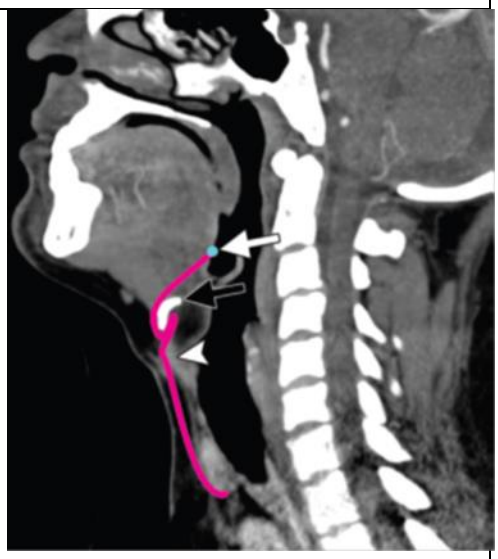
Lingual

Lateral neck



❖ Ectopic Thyroid

Congenital
F > M



Thyroid Caudal Migration:
Runs from the base of tongue at the foramen caecum down to its normal location anterior to larynx and upper trachea.

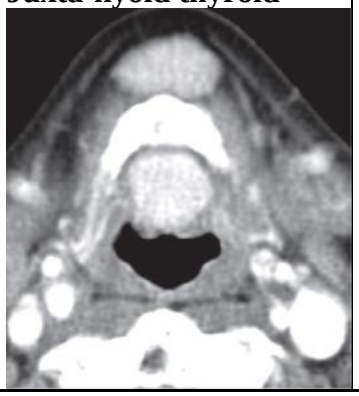
Ectopic Thyroid Location:
Lingual 90%
Juxtahyoid
Infrahyoid
Lateral neck

Radiological Features:
Midline or para-midline well defined soft tissue mass
NCCT: Hyperdense (70 HU) +/- Calcification
CECT: Avid homogenous contrast enhancement
T1: iso – Hyper compared to muscles
T2: Mild hyper
T1+C: Mild homogenous contrast enhancement

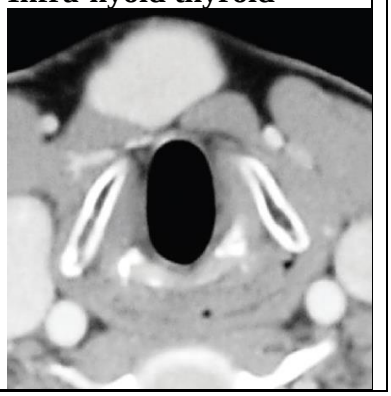
Orthotopic thyroid absent 70%–80%

Lingual thryoid

Juxta-hyoid thyroid



Infra-hyoid thyroid



❖ Diffuse Thyroid Enlargement

- **Acute Thyroiditis**
- **Autoimmune Thyroiditis**
  - **Graves' Disease**
  - **Hashimoto's thyroiditis**
  - **Riedel thyroiditis**
  - **Non-specific/atrophic**
  - **Silent thyroiditis**
  - **Postpartum thyroiditis**
- **Subacute Thyroiditis (DeQuervains)**

1) Graves' Disease

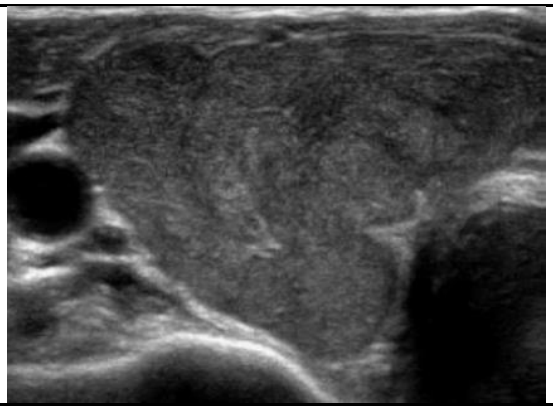
- Autoimmune thyroid disease
- Most common cause of thyrotoxicosis (up to 85%).
- F > M = 5:1

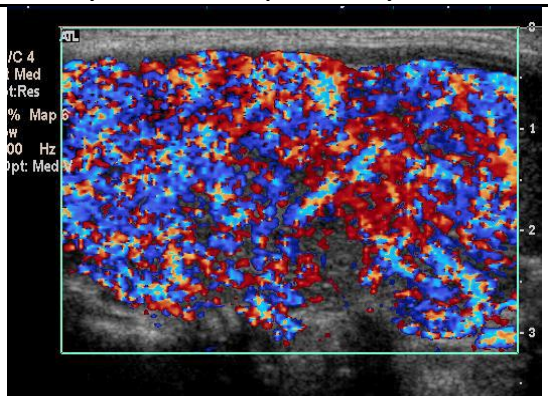
Serology:

- TSH: suppressed
- T3 & T4: elevated
- Thyroid receptor antibodies (TSI, TGI, TBII): positive

Imaging findings:

- Diffuse gland enlargement
- Diffuse heterogeneous echotexture
- Increased vascularity
  - PSV > 40 cm/sec has 96% sensitivity and 95% specificity for GD





2) Hashimoto's Thyroiditis

- Chronic lymphocytic thyroiditis or chronic autoimmune thyroiditis

- One of the common types of autoimmune thyroiditis
- 5 to 10% of the adult population is affected
- Autoimmune disease
- Middle aged females
- Strong familial predisposition

Serology:

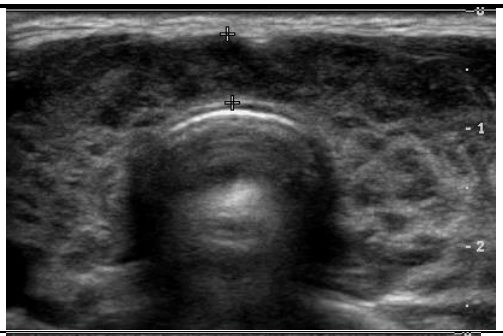
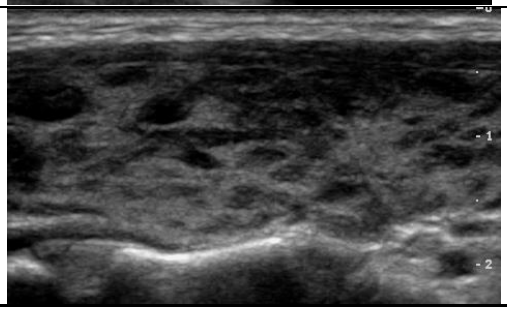
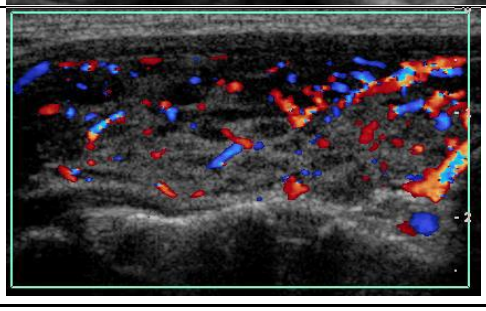
- Patients may be eu-, hypo-or hyperthyroid
- Anti-thyroglobulin antibodies: 95% of patients
- Thyroid peroxidase antibodies (TPO): 90-95% of patients

Radioactive iodine

- Early stages: may show increased uptake
- Late stages: single or multiple areas of reduced uptake (cold spots).

Imaging findings:

- Diffuse gland enlargement
- Diffuse / Patchy heterogeneous echotexture
- Micronodular pattern (***NOT*** multinodular goiter) = Multiple hypoechoic, ill-defined "nodules" 1-6mm in size
    - Geographic hypoechoic areas
    - Linear echogenic lines representing fibrosis
- Vascularity: normal or decreased

❖ Thyroid Nodule/Mass:

DD:

- Benign follicular nodule = Adenomatous/ Hyperplastic/ colloid nodule: 85%
- Follicular adenoma: 5%
- Carcinoma
  - Papillary: 60-80%
  - Follicular: 10-20%
  - Medullary: 5%
  - Anaplastic: 1-2%
- Thyroid lymphoma: 1%
- Metastases to thyroid: 1%

CLINICAL HIGH RISK FACTORS OF MALIGNANCY:

- History of radiotherapy in childhood or adolescence
- FDG-avid nodule at PET
- Cold nodule on thyroid scan
- Age <15 y or >45 y
- Males
- First-degree relative with thyroid cancer or type 2 MEN
- Personal history of thyroid cancer at lobectomy

US Features => Benign

- Uniform halo around nodule
- Predominantly cystic
- Avascular
- Enlarged thyroid with multiple nodules

US Features => Suspicious

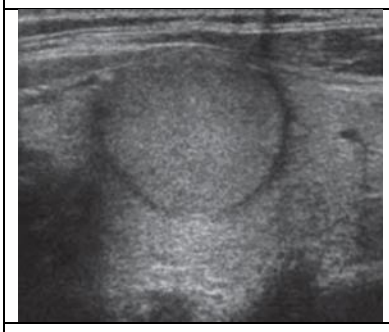
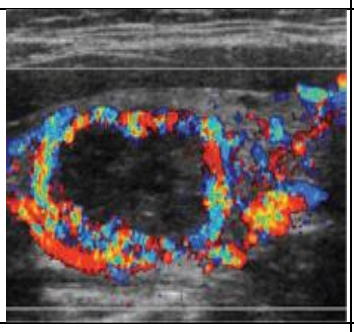
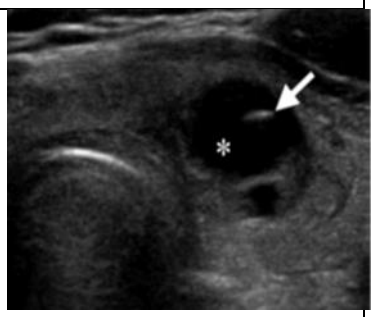
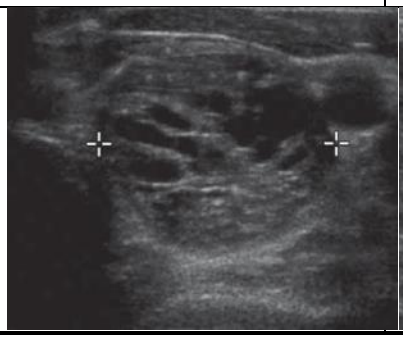
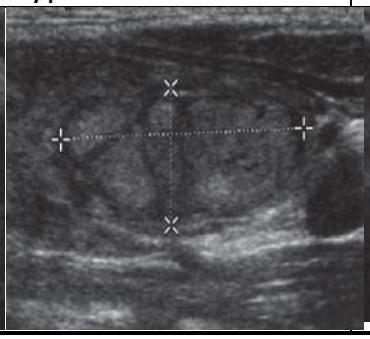
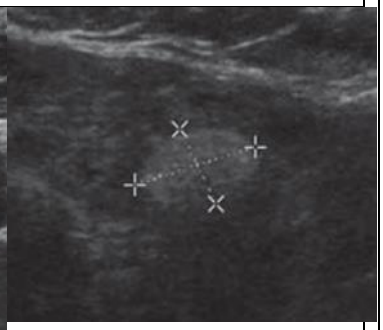
Microcalcifications
Extension beyond thyroid margin
Cervical LNs metastasis
Taller than wide in TS plane
Markedly hypoechoic
No halo around nodule
Ill-defined or irregular margin
Solid Increased central vascularity

Indications of FNA:

- Solid nodule
  - Suspicious US features ≥1 cm
  - Non-suspicious US features ≥1.5 cm
- Mixed cystic-solid nodule
  - Suspicious US features ≥1.5 cm
  - Non-suspicious US features ≥2 cm
- Multiple nodules
  - Normal intervening parenchyma
    - FNA of up to 4 suspicious nodules
    - FNA of largest nodule
  - No normal intervening parenchyma => FNA not necessary
- Substantial growth (>50%) since previous US examination
- Suspicious cervical LNs.

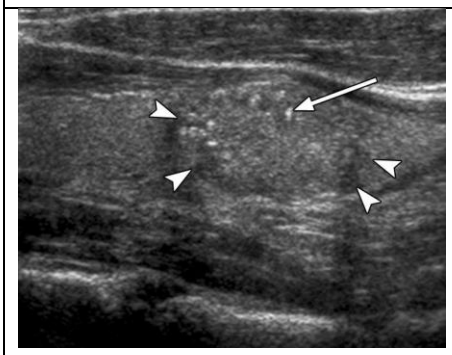
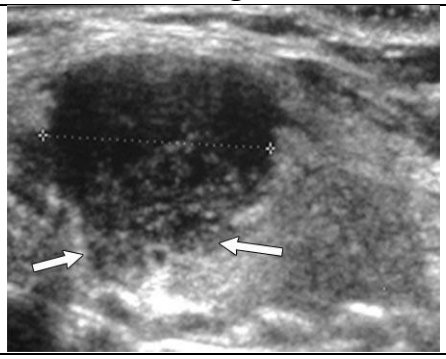
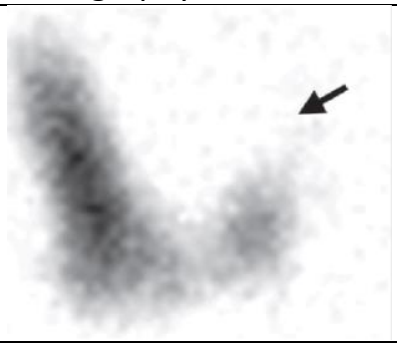
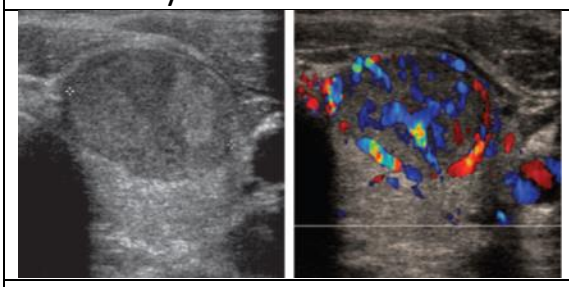
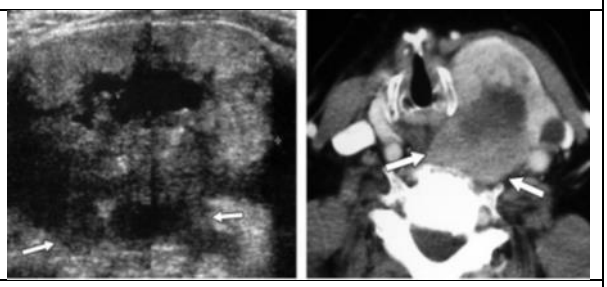
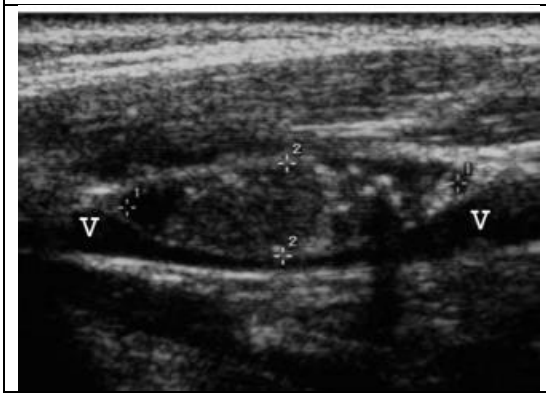
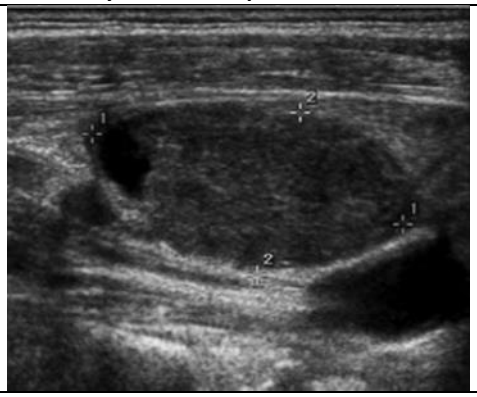
Benign Follicular Nodules

Adenomatous/Hyperplastic nodule	Colloid nodule
Multinodular > Solitary Predominantly solid nodule Surrounded by halo sign	Predominantly cystic nodule Internal septations + Echogenic foci + Comet tail artifact

Isoechoic Nodule Halo sign	Peripheral vascularity	Cystic + Echogenic foci + Comet tail artifact
		
Spongioform Nodules	Giraffe hide Nodule = Echogenic blocks + Hypoechoic bands	Echogenic Nodule
		

Follicular Adenoma

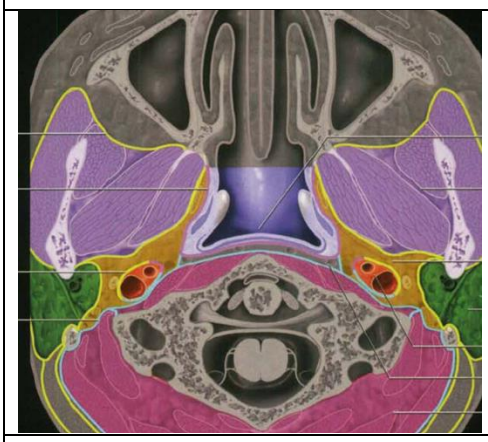
Solitary nodule in a background of normal-appearing thyroid tissue.
Cytology report => Follicular neoplasm => Follicular adenoma (70-85%) or follicular carcinoma (15-30%)
PET is not helpful in distinguishing between follicular adenoma and follicular carcinoma.
Surgical hemithyroidectomy is indicated for a follicular neoplasm because malignancy cannot be excluded on the basis of FNA findings

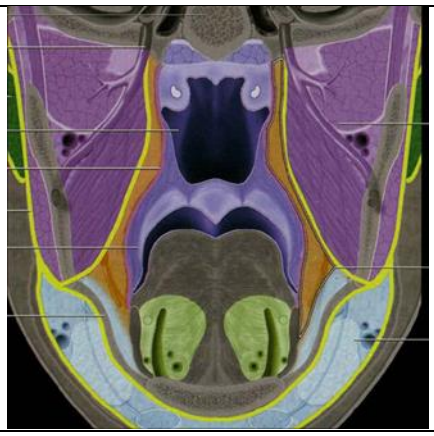
Suspicious US Features	
Solid nodule + Microcalcification	Solid nodule + Markedly hypoechoic + Ill defined margins
	
	Scintigraphy => Cold nodule
	
Solid nodule + Increased internal vascularity	Infiltration of posterior margins
	
LN + Microcalcifications	LN + Cystic component
	

<table>
<tr><th>Papillary Carcinoma</th><th>Follicular Carcinoma</th><th>Medullary Carcinoma</th><th>Anaplastic Carcinoma</th></tr>
<tr><td>80%
F>>M
Age= middle age group</td><td>10%
F >> M
Age = 40 – 60 y</td><td>4%</td><td>1%</td></tr>
<tr><td>FNA is diagnostic</td><td rowspan="2">Cytology report =>
Follicular neoplasm =>
Follicular adenoma (70-85%) or follicular carcinoma (15-30%)</td><td rowspan="2">80% Sporadic
20% MEN type 2a</td><td rowspan="2">Wide local invasion</td></tr>
<tr><td>Early LN metastasis</td></tr>
<tr><td>Prognosis is very good</td><td>Prognosis is good</td><td>Prognosis is intermediate</td><td>Prognosis is poor</td></tr>
<tr><td>10y survival rate = 93%</td><td>10y relative survival rate = 85%</td><td>10y relative survival rate = 75%</td><td>1-year survival rate = 20%</td></tr>
<tr><td colspan="2">TTT => Total thyroidectomy
+/- Radioactive iodine ablation</td><td colspan="2">do not concentrate iodine => Radioactive iodine ablation and 131I scintigraphy cannot be performed
TTT => Total thyroidectomy</td></tr>
</table>

VII. Parapharyngeal Space

Anatomy





Content:

- **Fat**
- Minor salivary glands
- Internal maxillary artery
- Ascending pharyngeal artery
- Pterygoid venous plexus

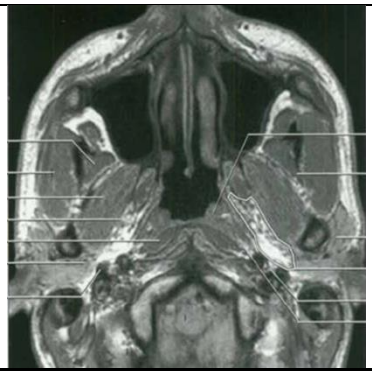
Primary lesions :

Rare

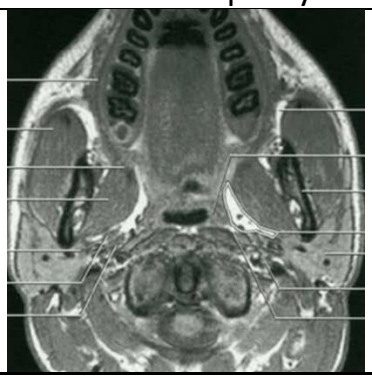
Completely surrounded by PPS fat.

- Benign mixed tumor (from minor salivary gland)
- Lipoma
- Atypical 2nd branchial cleft cyst

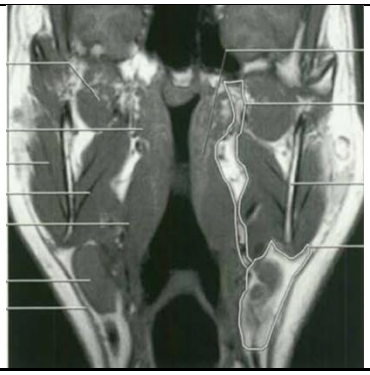
At level of nasopharynx



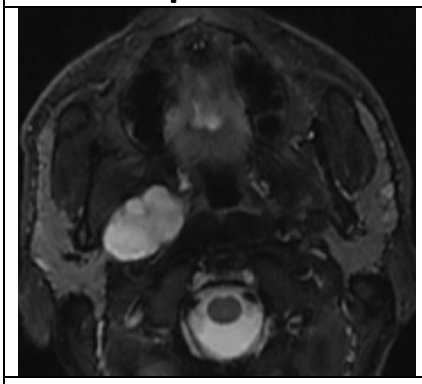
At level of Oropharynx

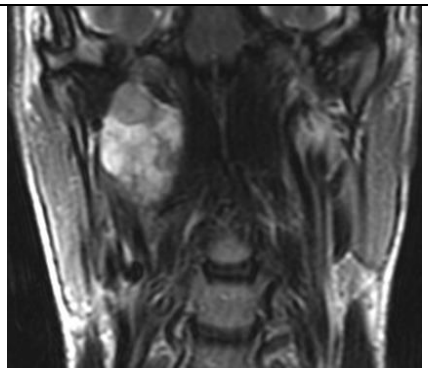


Coronal T1

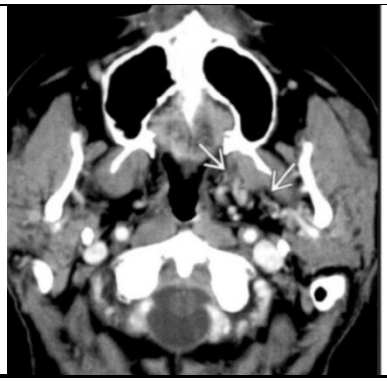


Pleomorphic Adenoma



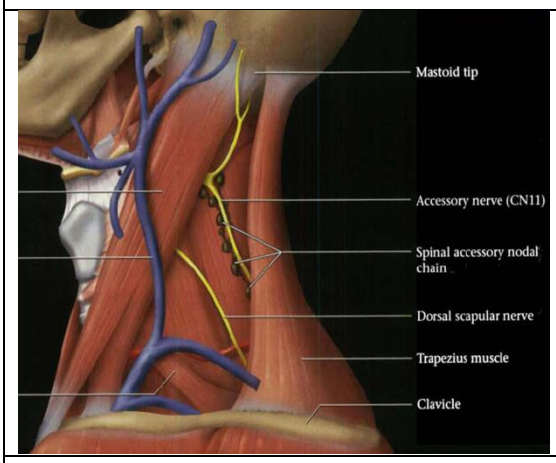


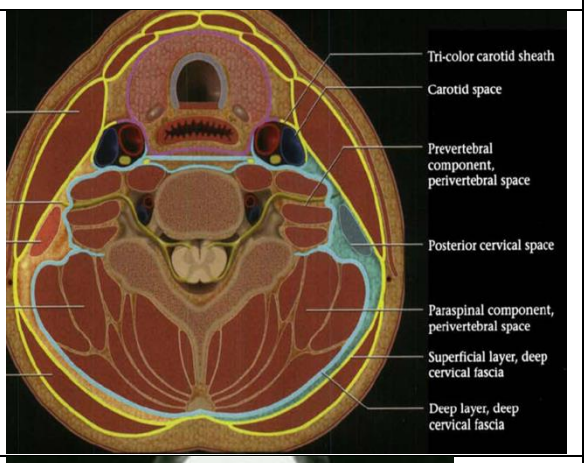
PTERYGOID VENOUS PLEXUS ASYMMETRY



VIII. Posterior Cervical Space

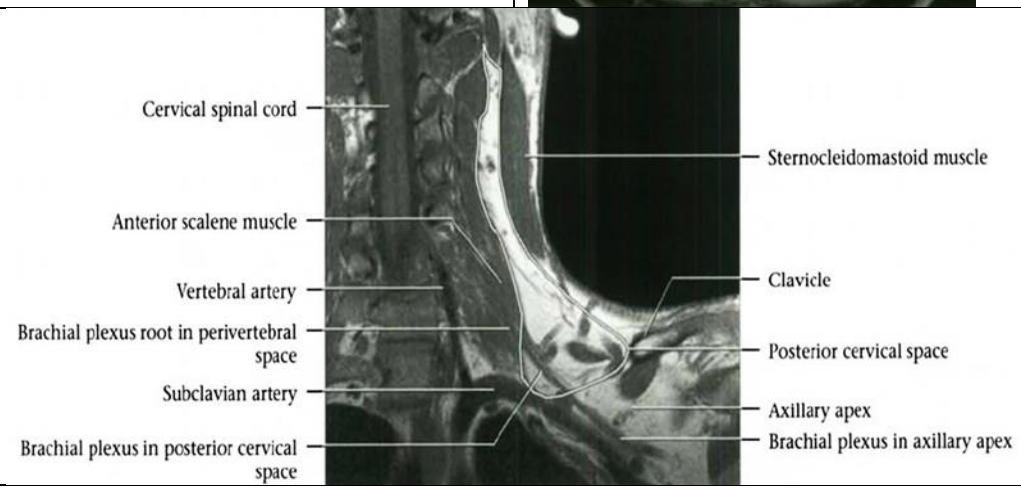
Anatomy





Content:

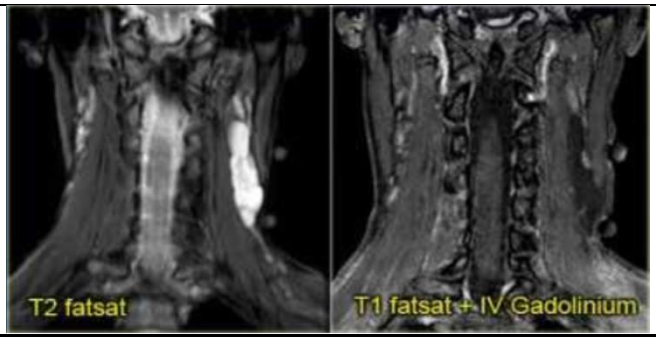
Fat is primary occupant
Accessory nerve (CNII)
Spinal accessory LNs (Level 5)
Level 5A: above cricoid cartilage
Level 5B: below cricoid cartilage



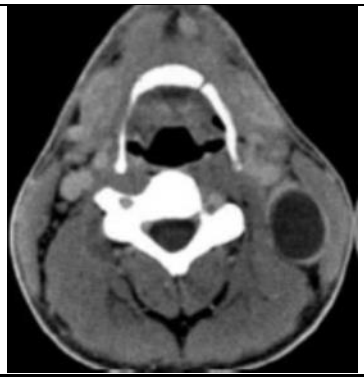
A. Cystic Lesions

Lymphangioma = Cystic Hygroma

Well defined multilocular cystic lesion
+/- Fluid / fluid level
+C: No enhancement

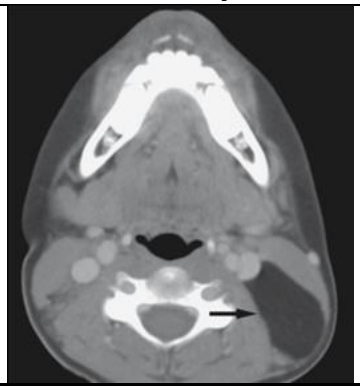


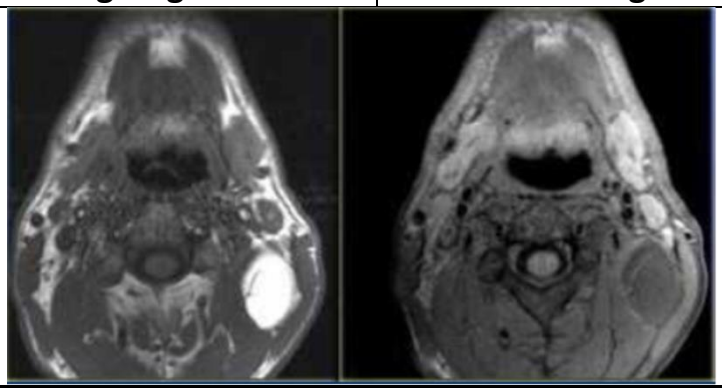
3rd Branchial Cleft Cyst



Lipoma

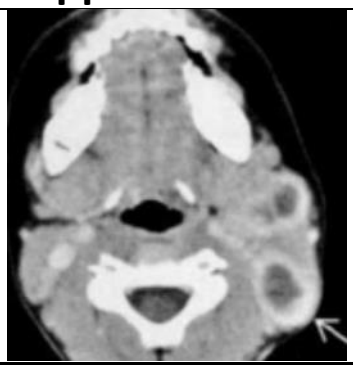
CT: Fat density	T1: High signal	T1 FS: Loss of signal





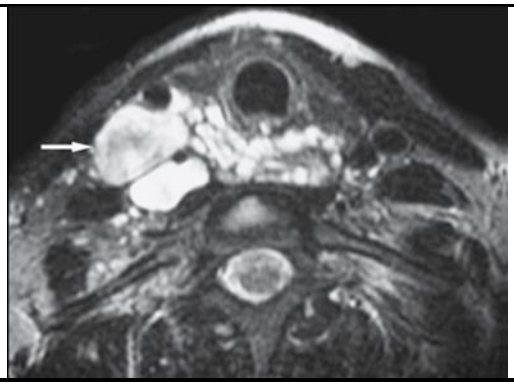
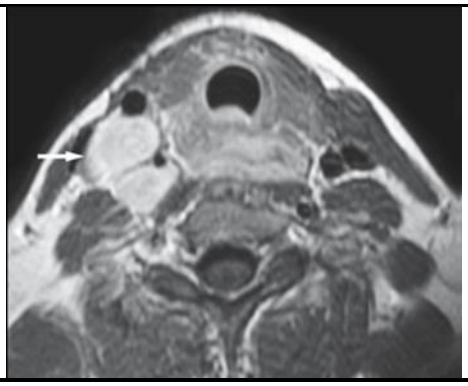
B. Soft Tissue Lesions

LNs

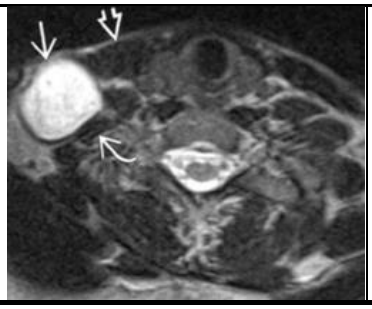
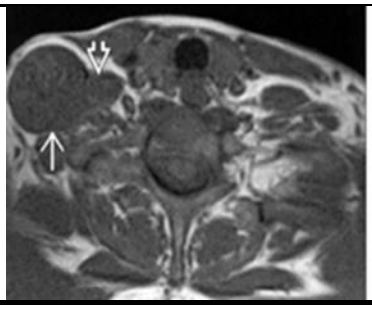
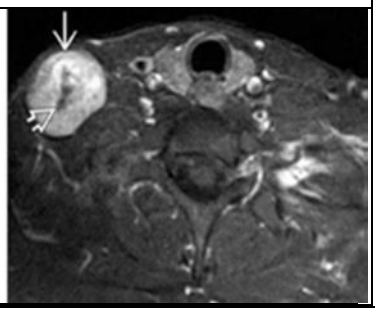
NHL	Suppurative LNs	Metastatic LNs
		

Neurogenic Tumors

Neck Plexiform Neurofibroma

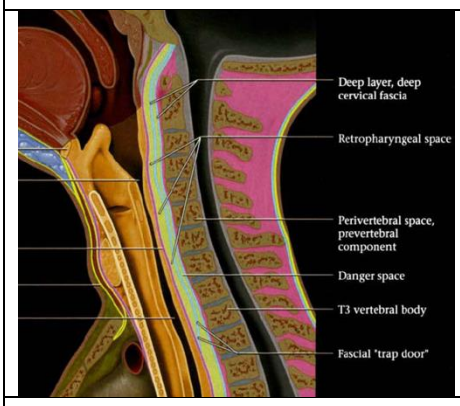



SCHWANNOMA

IX. Retropharyngeal Space

Anatomy



<u>Suprahyoid neck RPS</u>

Fat is primary occupant

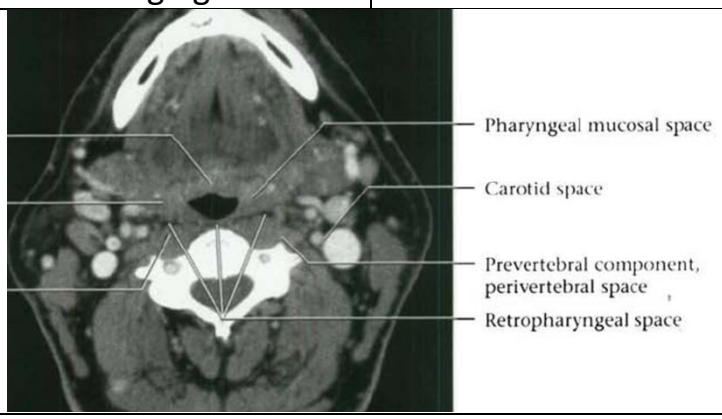
RPS LNs:

- Lateral group = LNs of Rouviere
- Medial group: Less often visible on imaging

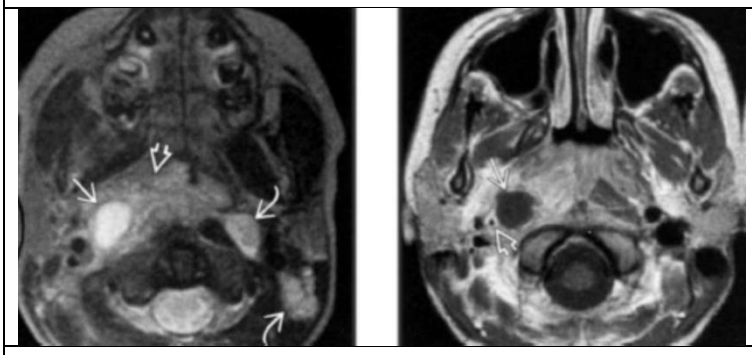
<u>Infrahyoid neck RPS</u>

Fat only in IHN RPS

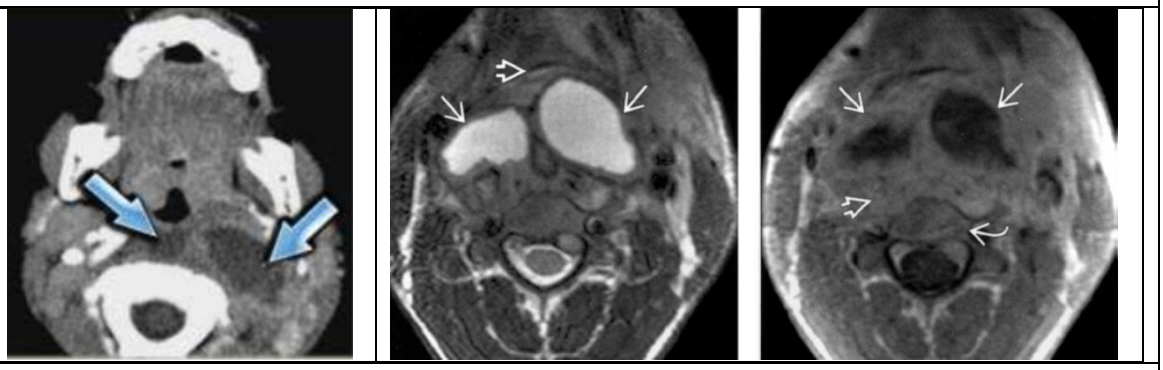
No RPS LNs below hyoid bone



Retropharyngeal Cellulitis + Suppurative Retropharyngeal LNs



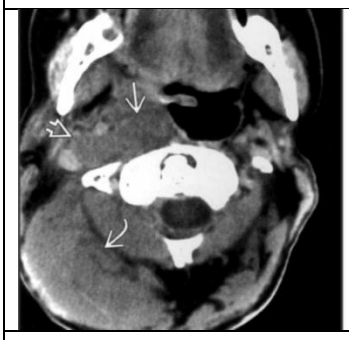
Retropharyngeal Abscess + Suppurative Retropharyngeal LNs



Nasopharyngeal Carcinoma + Metastatic Retropharyngeal LNs

> 5mm short axis diameter	> 8mm long axis diameter

NHL

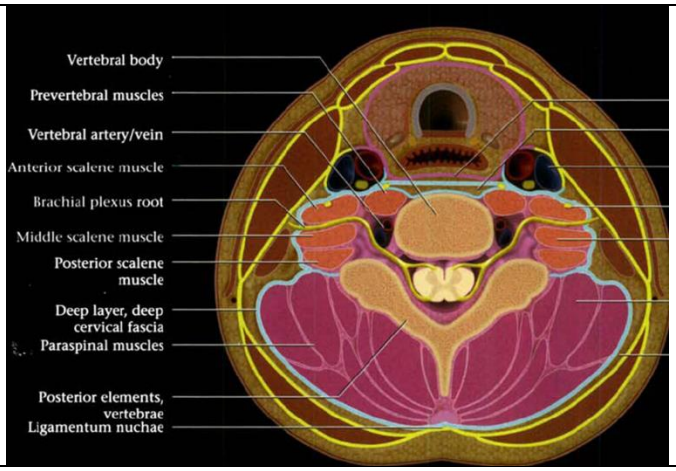


Post-Radiotherapy Retropharyngeal Edema

Retropharyngeal ICA

X. Perivertebral Space

Anatomy



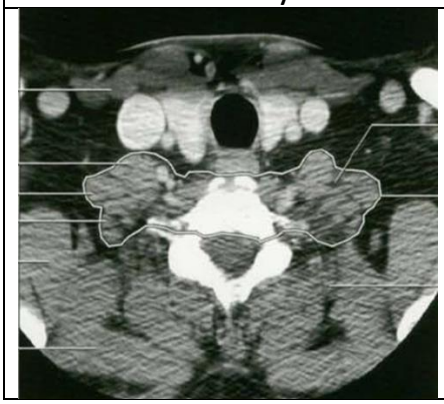
Contents:

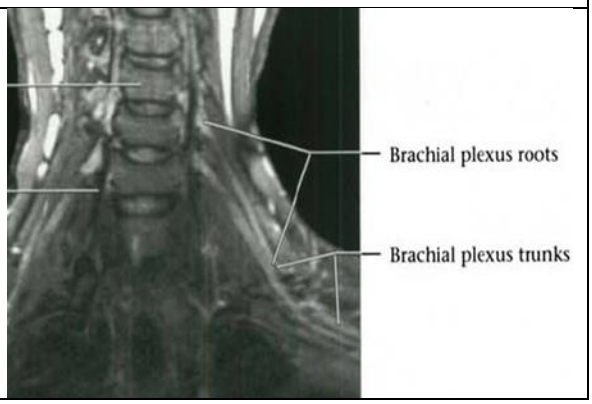
A) Prevertebral Component:

- Prevertebral muscles (longus colli & capitis)
- Scalene muscles (anterior, middle & posterior)
- Brachial plexus roots
- Phrenic nerve (C3-C5)
- Vertebral artery & vein
- Vertebral body

B) Paraspinal Component:

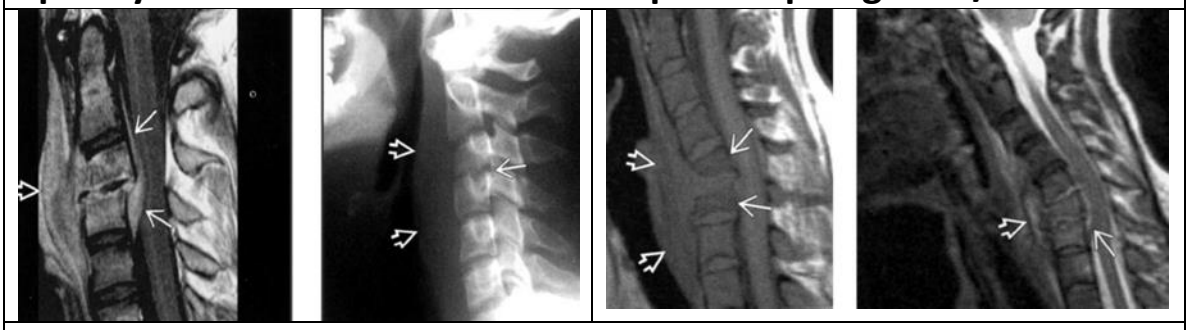
- Paraspinal muscles
- Vertebral posterior neural arch





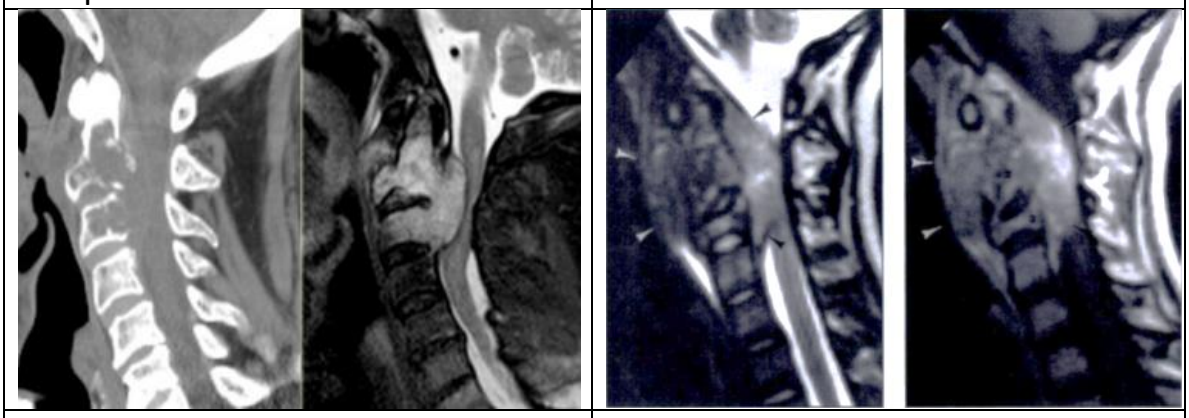
A) Vertebral Lesions

Spondylodiscitis => Prevertberal + Epidural phlegmon / abscess

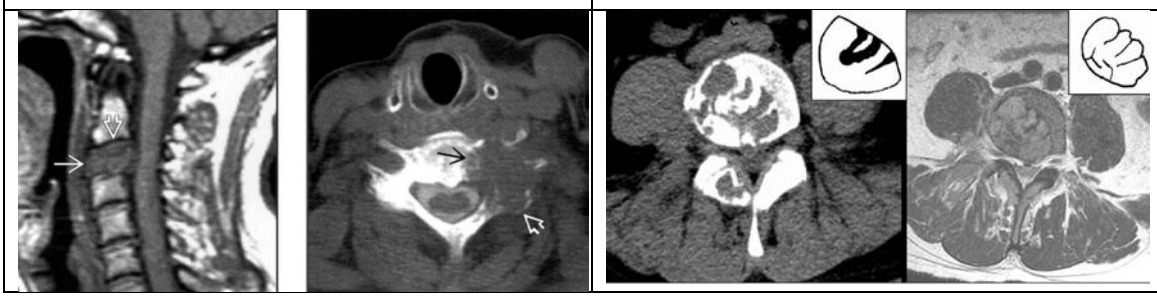


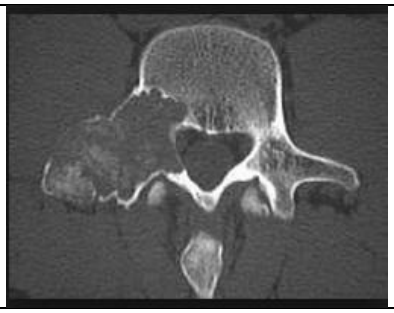
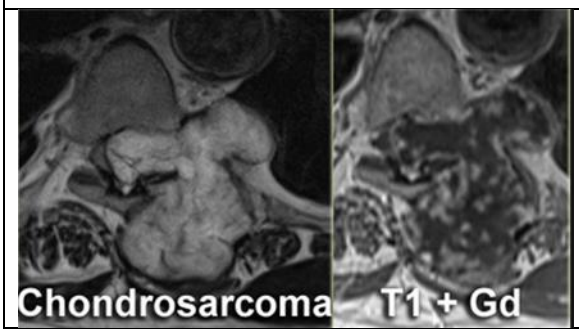
Vertebral Chordoma

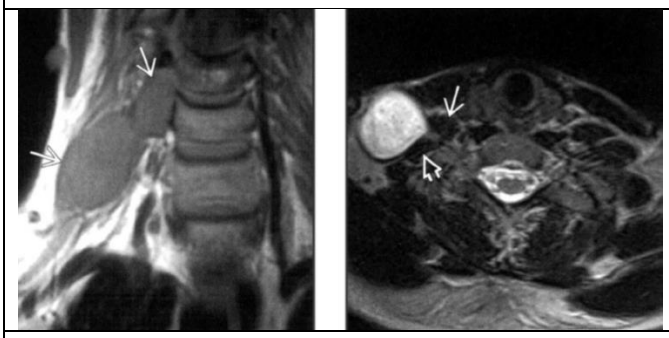
Rare low grade malignant tumor Arise from notochordal remnants Age: Adults > 30y	**<u>Location:</u>** Sacrococcygeal (60%) Sphenooccipital (25%) **Spine (especially C2) (15%)**
<u>Radiological Features:</u> Vertebral body expansile / destruction / erosion / remodeling. Epidural + perivertberal soft tissue components.	T1: Low signal + areas of hemorrhage T2: very high signal (Bubbly-like) + Cord edema +C: Moderate enhancement



Vertebral Metastasis	Plasmacytoma
	"Mini-brain" appearance



Aneurysmal Bone Cyst	Osteoblastoma
	
Chondrosarcoma	
	

B) Soft tissue lesions
BRACHIAL PLEXUS SCHWANNOMA

Soft tissue Sarcoma

Oral Cavity

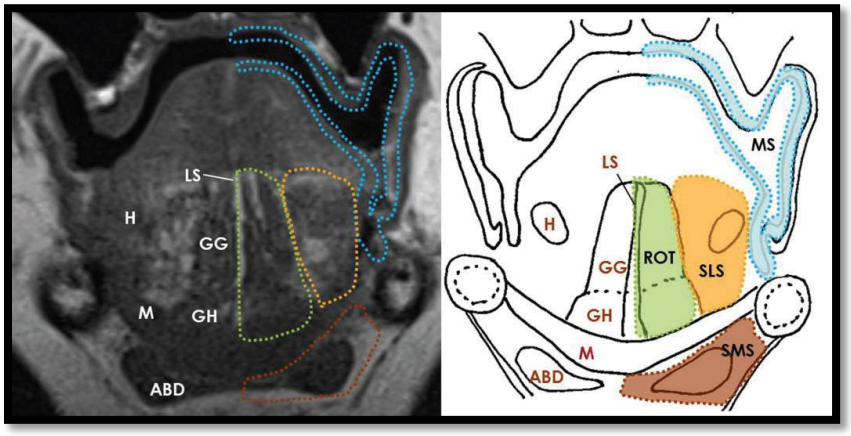
Anatomy

Oral cavity => 4 Regions

1) Oral mucosal space (OMS)
2) Sublingual space (SLS)
3) Submandibular space (SMS)
4) Root of tongue (ROT)

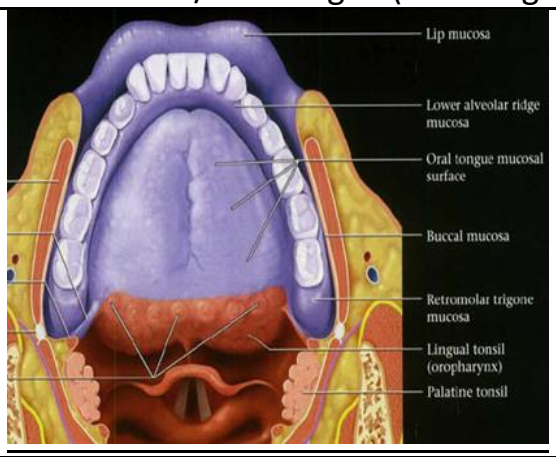
Floor of mouth:

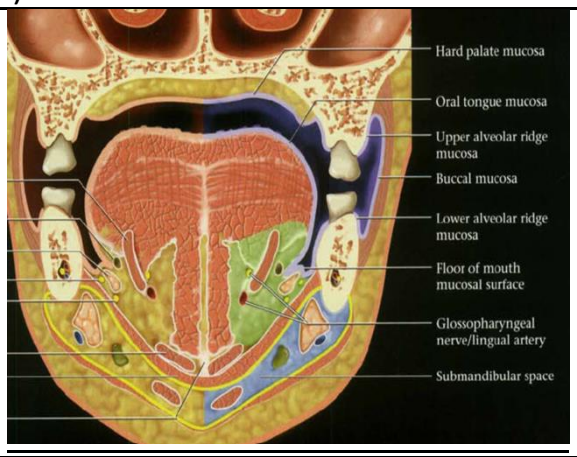
1) Root of Tongue
2) Sublingual space



1) Oral Mucosal Space (OMS)

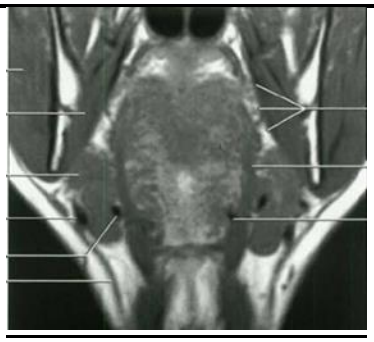
- Mucosal lip
- Upper alveolar ridge mucosal surface
- Lower alveolar ridge mucosal surface
- Buccal mucosa: line inner surface of cheeks and lips.
- Floor of mouth mucosal surface
- Hard palate mucosal surface
- Anterior 2/3 of tongue (oral tongue) mucosal surface





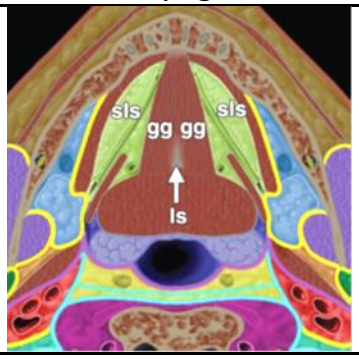
2) <u>Submandibular Space (SMS)</u>

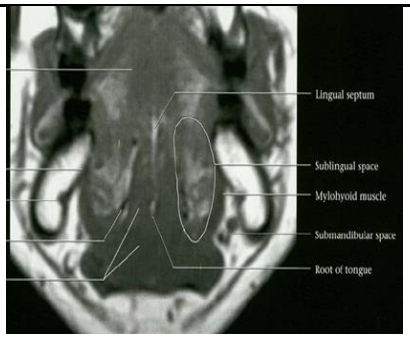
- Between mylohyoid muscle and hyoid bone
- SMS communicates posteriorly with inferior PPS and posterior SLS.
- SMS continues inferiorly as anterior cervical space.
- Content:
    - Superficial portion of submandibular gland: Wraps around posterior margin of mylohyoid muscle
    - Submental LNs (level IA) & Submandibular LNs (level IB)
    - Facial vein and artery
    - Inferior loop of CN12
    - Anterior belly of digastric muscles



3) <u>Sublingual Space (SLS)</u>

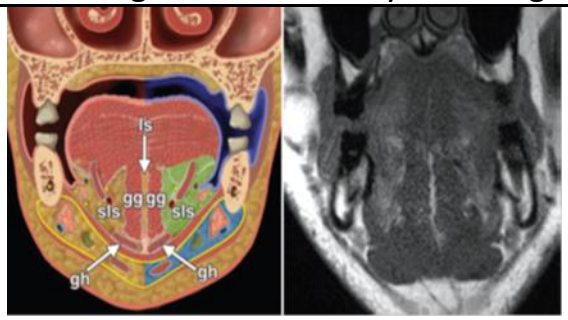
- Between mylohyoid muscle inferolaterally and genioglossus medially
- Both SLS communicate anteriorly beneath frenulum.
- SLS communicates posteriorly with SMS.
- Content:
    - Hypoglossal Nerve
    - Lingual nerve, artery & vein
    - Sublingual glands and ducts
    - Deep portion of submandibular gland and duct
    - Hyoglossus muscle

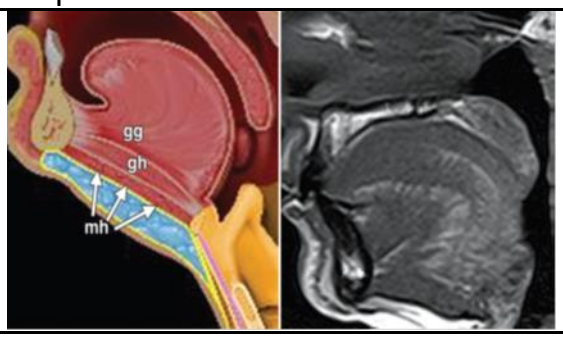




4) Root Of Tongue:

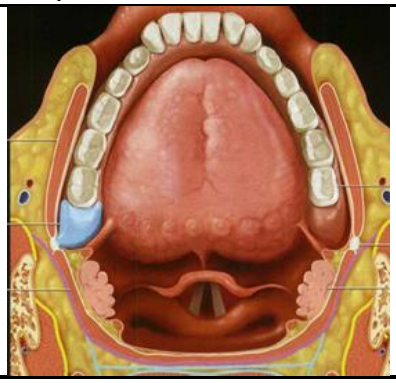
- Genioglossus + Geniohyoid + Lingual septum

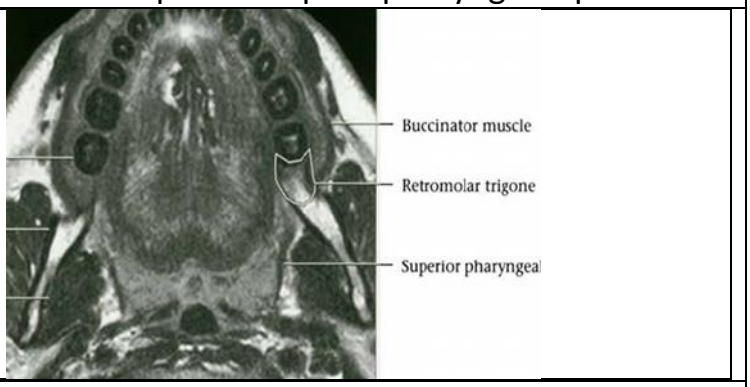




5) Retromolar Trigone (RMT):

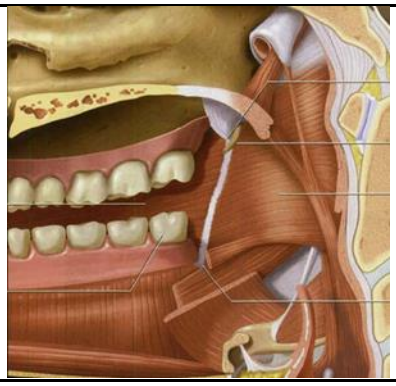
- Small triangular region of mucosa behind last mandibular molar
- Anatomical crossroads of oral cavity, oropharynx, soft palate, buccal space, floor of mouth, masticator space and para-pharyngeal space.

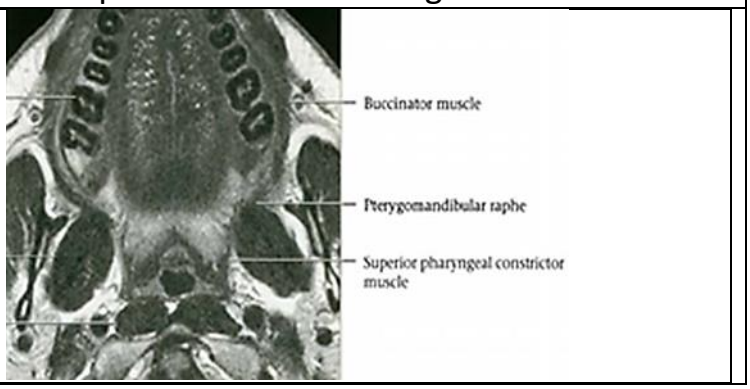




6) Pterygomandibular Raphe

- Fibrous band extending from posterior mandibular mylohyoid line to medial pterygoid plate Hamulus.
- Junction of oropharynx posteriorly and oral cavity anteriorly
- Lies between anterior tonsillar pillar & retromolar trigone

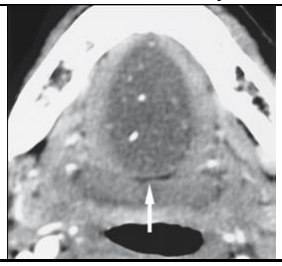
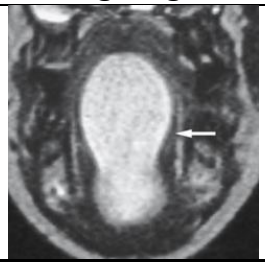
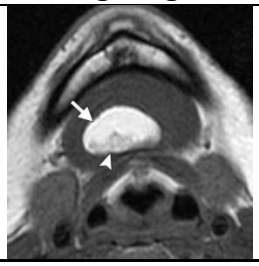
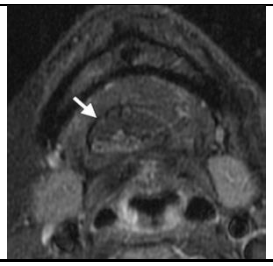




❖ Cystic Lesions

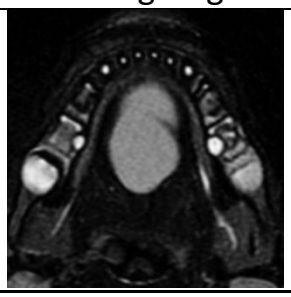
Dermoid Cyst:

Midline well-defined cystic lesion.
Fat, fluid or mixed contents ± Calcification

CT: Fat density	T2: High signal	T1: High signal	T1 FS: Loss of signal
			

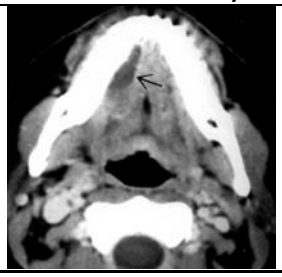
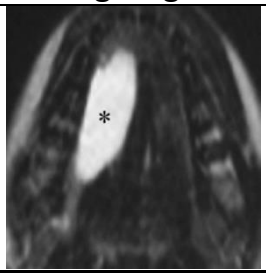
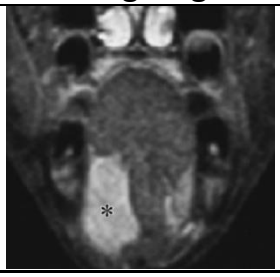
Epidermoid Cyst

Midline well-defined cystic lesion. Fluid content

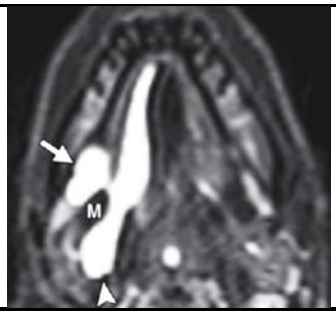
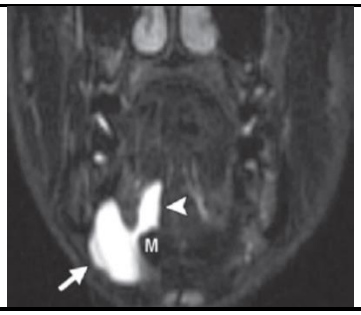
CT: Fluid density	T2 FS: High signal	T1 +C FS: Low signal
		

Simple Ranula

Sublingual space well-defined, cystic lesion. Fluid content

CT: Low density	T1: Low signal	T2: High signal	STIR: High signal
			

Diving Ranula => SLS + SMS well defined cystic lesion.

2nd Branchial Cleft Cyst

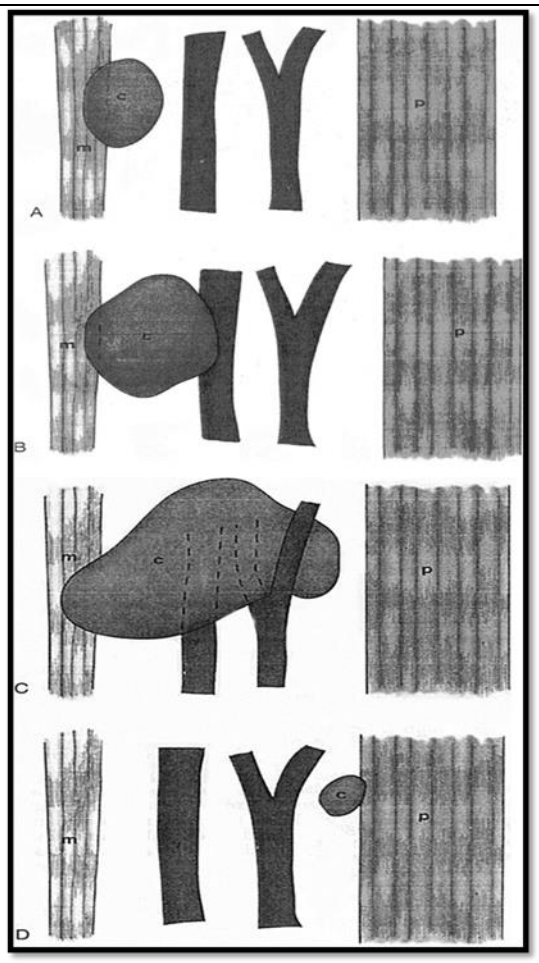
95% of all branchial cleft anomalies

Well defined cyst +/- sinus or fistula

Along anterior surface of sternomastoid muscle
Posterior to submandibular gland

Bailey Classification:

Type I : Cyst away from vessels
Type II: Cyst lateral to carotid space (most common)
Type III: Cyst extends medially between ICA & ECA.
Type IV: Cyst deep to carotid sheath; within parapharyngeal space.

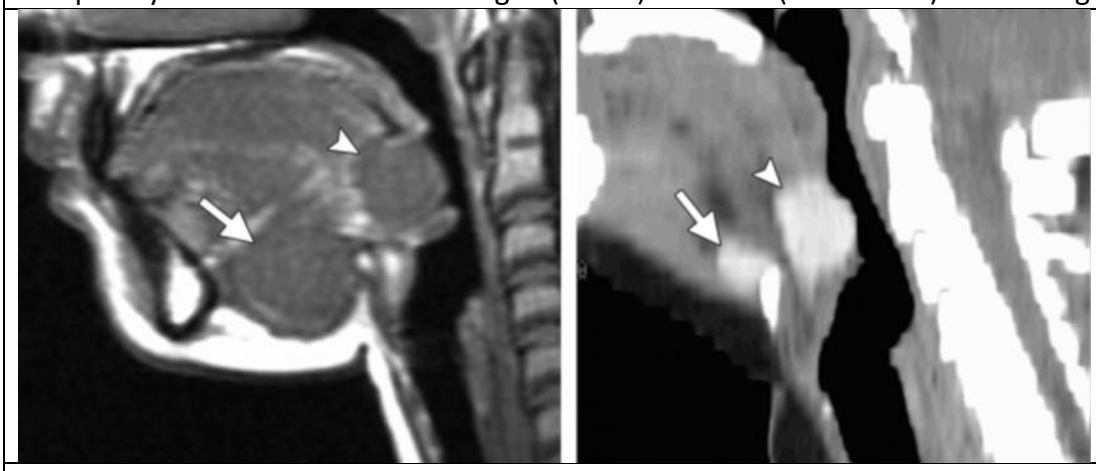


Lingual Thyroid

Radiological Features:

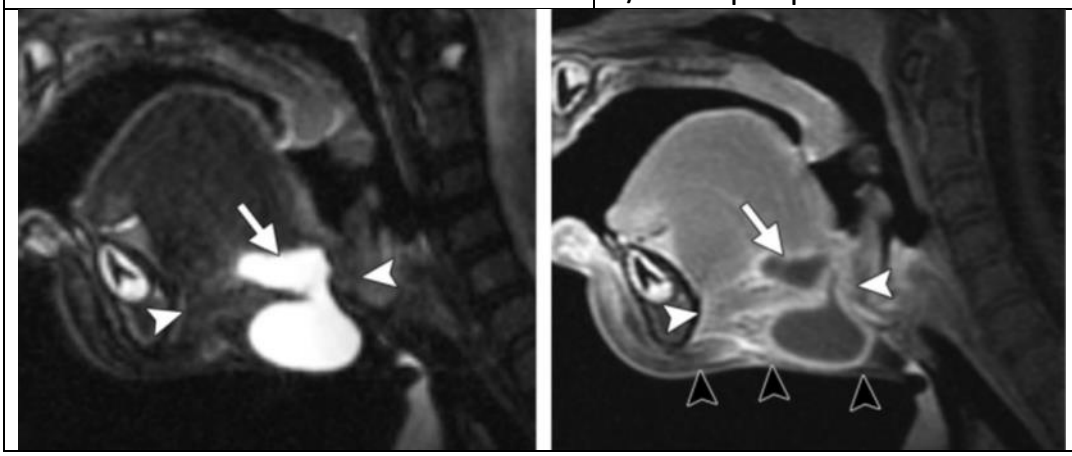
Midline or para-midline well defined soft tissue mass
NCCT: Hyperdense (70 HU) +/- Calcification
CECT: Avid homogenous contrast enhancement
T1: iso – Hyper compared to muscles
T2: Mild hyper
T1+C: Mild homogenous contrast enhancement
Orthotopic thyroid absent 70%–80%

Ectopic thyroid in the root of the tongue (arrow) and base (arrowhead) of the tongue.



Thyroglossal Duct Cyst

Radiological Features: Midline / Para-midline Well defined cyst	T1: High signal due to high proteinaceous content T2: High signal +C: No enhancement +/- thin peripheral enhancement



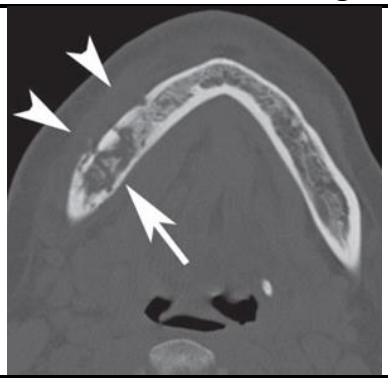
Odontogenic Osteomyelitis

Causes:
Dental caries
Dental extractions
Dental or mandibular fractures
Osteoradionecrosis
Hematogenous spread of infection.

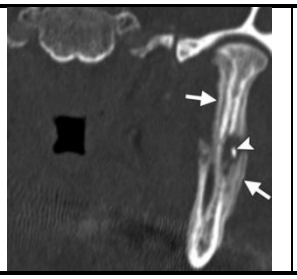
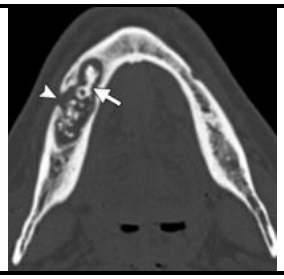
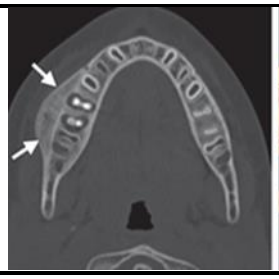
Risk factors:
Diabetes mellitus
Alcoholism
Malnutrition
Sickle cell disease
Collagen vascular diseases
Radiation therapy

Acute Osteomyelitis:
Peri-apical lucency
Ill defined osteolytic lesion
Cortical disruption
Periosteal reaction
Soft-tissue inflammatory changes
Smudging of fat planes
Skin / Fascial thickening

Sublingual / Submandibular Space Abscess:
Central necrosis
Marginal enhancement
Soft-tissue inflammatory changes
Smudging of fat planes
Skin / Fascial thickening

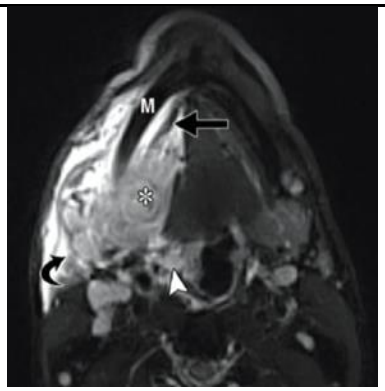


Chronic Osteomyelitis:
Sclerotic sequestrum
Surrounding low-attenuation zone
Sinus tract through the buccal lingual cortex.
Periosteal new bone formation “Lamellated = onion skinning”

Ludwig Angina

Serious, life-threatening infection of the floor of the mouth that rapidly extends bilaterally to the soft tissues of the oral cavity.
Complication of odontogenic infection.
Cellulitis – No abscess.

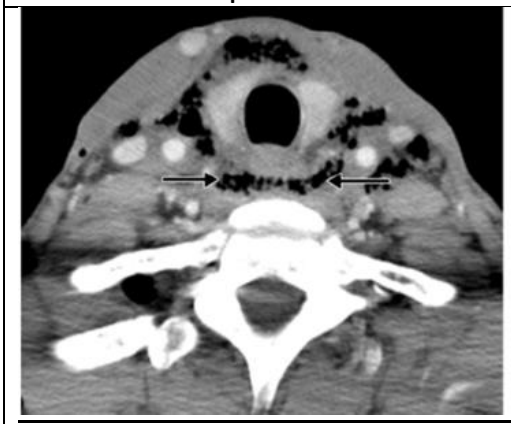


Descending Necrotizing Mediastinitis

Rare but emergent complication of odontogenic infection.
Infection spreads from the oral cavity or oropharynx to the mediastinum by way of the retropharyngeal space (“danger” space).

Radiological features:

Mediastinal fluid collections + Gas loculi
Smudging of mediastinal fat.
Pericardial or pleural effusions



❖ Submandibular Gland Lesions

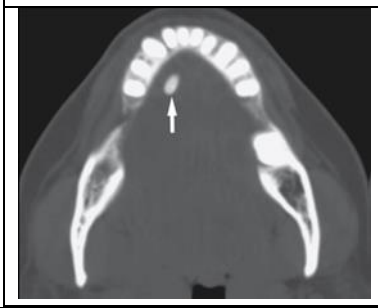
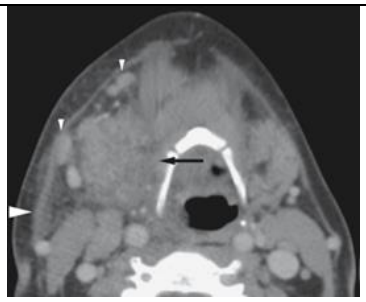
Submandibular Sialadenitis

- Bacterial = acute suppurative; Unilateral, localized infection.
- Viral = acute viral; 75% bilateral, systemic viral infection.
- Calculus-induced = secondary to ductal obstruction from stone; unilateral

Radiological features:
Diffuse gland enlargement.
Diffuse heterogeneous enhancement.
Stranding of the overlying fat planes.
Thickening of the overlying fascia

Abscess:
Well defined collection
Marginal enhancement
Stranding of overlying fat planes.
Thickening of overlying fascia

Submnadibular duct stone	Submandibular sialadenitis	Submandibular abscess

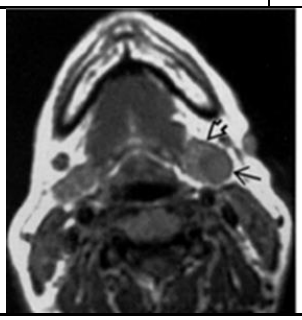
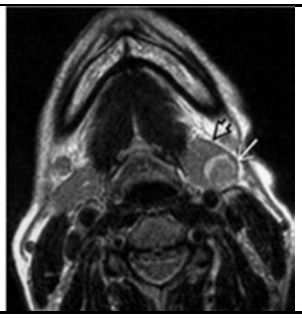



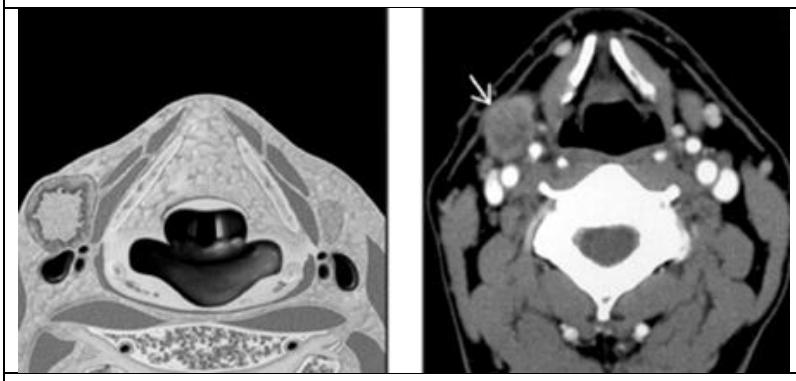
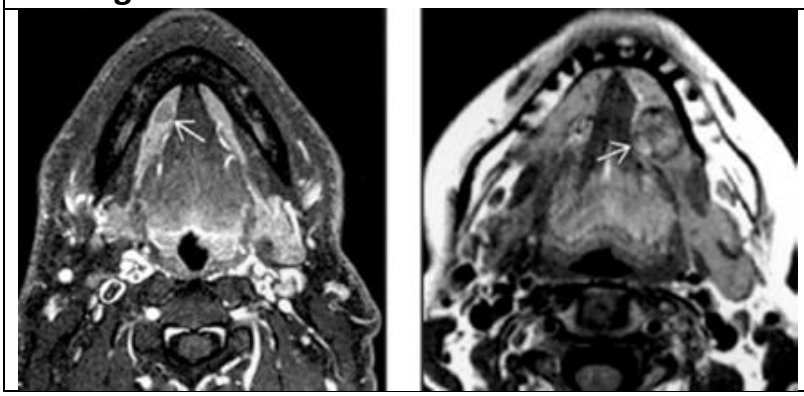
Pleomorphic Adenoma = Benign Mixed Tumor

Most common salivary gland tumor
Age = 40 – 50y
Sex: F > M = 2:1

Radiological features:
Solitary unilateral
Well defined lobulated lesion Homogenous enhancement
+/- Calcifications

Distribution:
85% in parotid glands
8% in submandibular glands
0.5-1% in sublingual glands
6.5% in minor salivary glands on mucosal surface of Soft palate > > oropharyngeal mucosal space> nasopharyngeal mucosal space

Malignant Minor Salivary Gland Tumors	
Adenoid cystic carcinoma Mucoepidermoid carcinoma Adenocarcinoma: less common.	Low grade tumors: well defined High grade tumors: Ill defined Heterogeneous enhancement Invade surroundings Perineural spread
<u>Distribution:</u> Mucosa of oral cavity, pharynx and tracheobronchial tree Most common location is hard palate-soft palate junction Submandibular and sublingual glands.	
<u>TNM Staging:</u> T1: < 2 cm without extraparenchymal extension T2: 2-4 cm without extraparenchymal extension T3: Tumor 4-6 cm with extraparenchymal extension T4: > 6 cm ± invades adjacent structures (maxilla, nose, sinus)	
Submnadibular Gland	
	
Sublingual Gland	
	

❖ Oral Cavity Cancer

Subsites:	**Pathology:**
(A) Lips **(B) Floor Of The Mouth** **(C) Oral Tongue (Ant 2/3 Tongue)** **(D) Buccal Mucosa** **(E) Upper & Lower Gingivae** **(F) Hard Palate** **(G) Retromolar Trigone**	❖ **SCCa** ❖ **Malignant minor salivary gland tumors:** • **Adenoid cystic carcinoma** • **Mucoepidermoid carcinoma** • **Adenocarcinoma: less common.**

TNM Staging:

T1: < 2 cm without extraparenchymal extension

T2: 2-4 cm without extraparenchymal extension

T3: Tumor 4-6 cm with extraparenchymal extension

T4A: Tumor invades adjacent structures:

Lip: cortical bone, inferior alveolar nerve, floor of mouth, skin.

Oral cavity: cortical bone, intrinsic or extrinsic muscles of tongue, maxillary sinus, skin

T4B: Tumor invades masticator space, pterygoid plates, skull base, ICA.

Tumors stage I or II => treated with single-modality therapy (either surgical resection or radiation therapy)

Tumors stage III or IV => multimodality therapy with a combination of chemotherapy, radiation, and surgical resection.

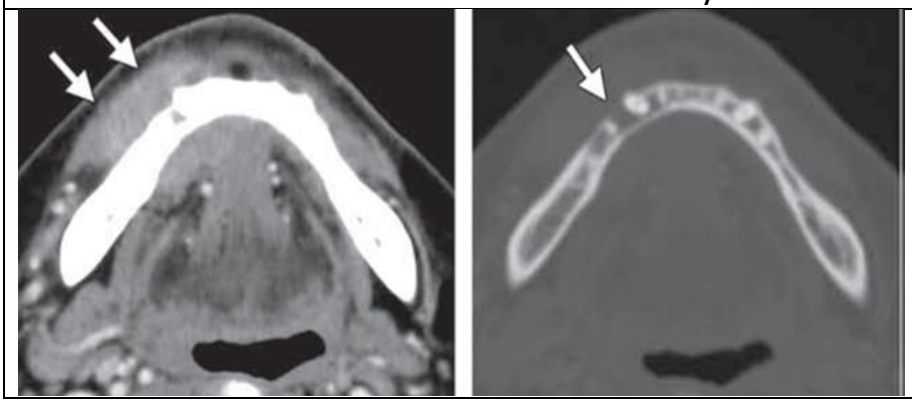
1) Lip:

Spread to:

Skin

Deep extension to orbicularis oris muscle.

Osseous erosion of buccal surface of maxillary or mandibular alveolar ridge.



2) ORAL TONGUE:

Involvement of the intrinsic muscles of the tongue => T4a lesion
Floor of mouth invasion => T4a Lesion:

Posterior oral tongue: Follows hyoglossus muscle into floor of mouth

Lateral oral tongue: Follows mylohyoid muscle into floor of mouth.

Bone CT preferred for evaluation of mandibular cortex invasion
Evaluation of neurovascular bundle is essential
Evaluation of midline of the tongue and the contralateral neurovascular bundle => important for surgical planning because any invasion of the midline precludes hemiglossectomy.

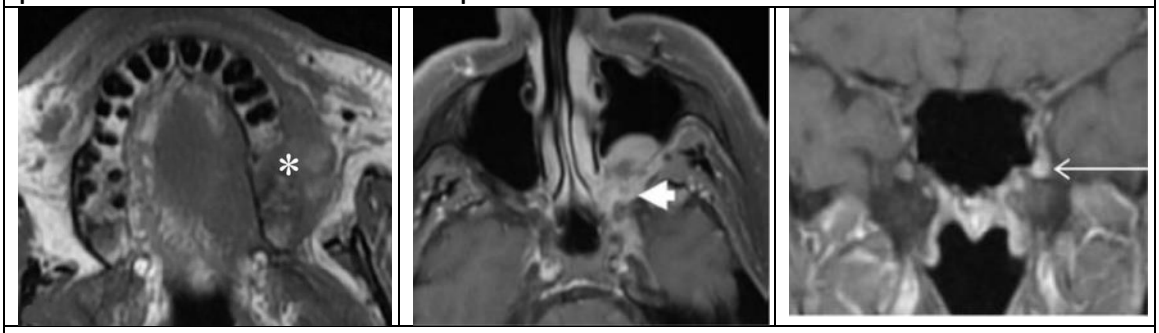
Lateral oral tongue illdefined enhancing lesion	Sublingual space / floor of mouth spread	Malignant submandibular LN

3) Buccal / Gingival Mucosa:

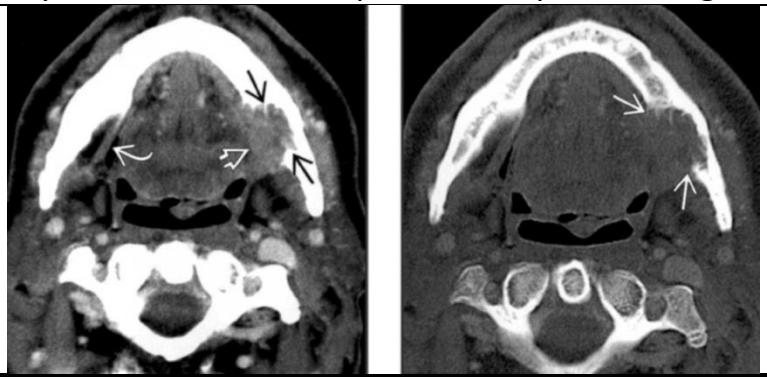
Puffed-cheek CT Scans Of The Oral Cavity
Bulky exophytic mass, subtle wall thickening, and ulceration
Submucosal spread, Buccinator muscle invasion
Erosion of maxilla/mandible alveolar margin => T4a Lesion
Skin invasion => T4a lesion

A tumor of the buccal mucosa of the cheek	A tumor from the buccal surface of the gingiva of the right maxillary alveolus => Cortical destruction of the maxillary alveolar margin.

Maxillary alveolar margin destructive SCCa lesion => spread to pterygo-palative fossa => Perineural spread to F. Rotundum



Mandibular alveolar margin destructive lesion => Erosion of mabdible, Mylohoid ms invasion, perineural spread along inferior alveolar nerve.



4) Retromolar Trigone:

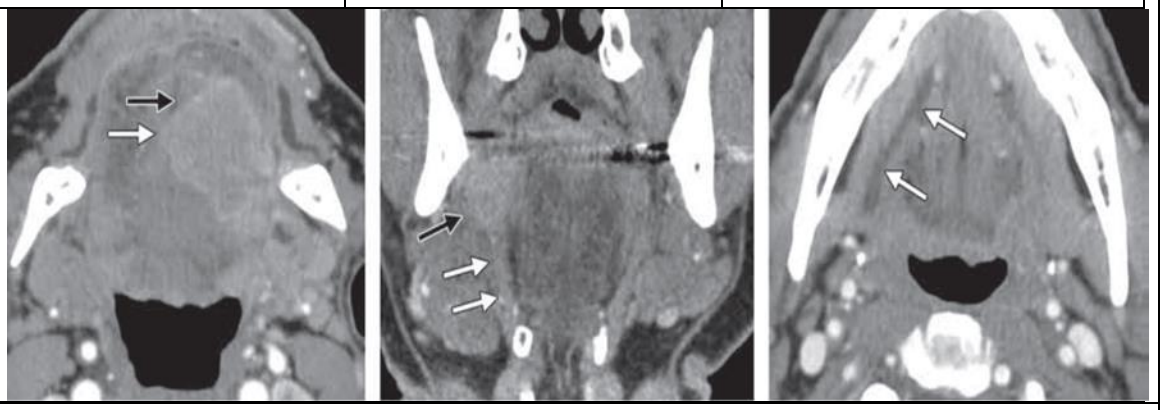
Posterior spread => Mandibular ramus, masticator space, perineural CNV3
Anterior spread => Along alveolar ridge
Inferior spread => perineural spread along inferior alveolar nerve
Superior spread => along Pterygo-mandibular raphe to inferior margin of medial pterygoid plate at hamulus

5) Floor of Mouth:

Submucosal spread
Invasion of lingual neurovascular bundle, mylohyoid and hyoglossus ms.
Erosion of the mandible.

Evaluation of the neurovascular bundle & Midline lingual septum.

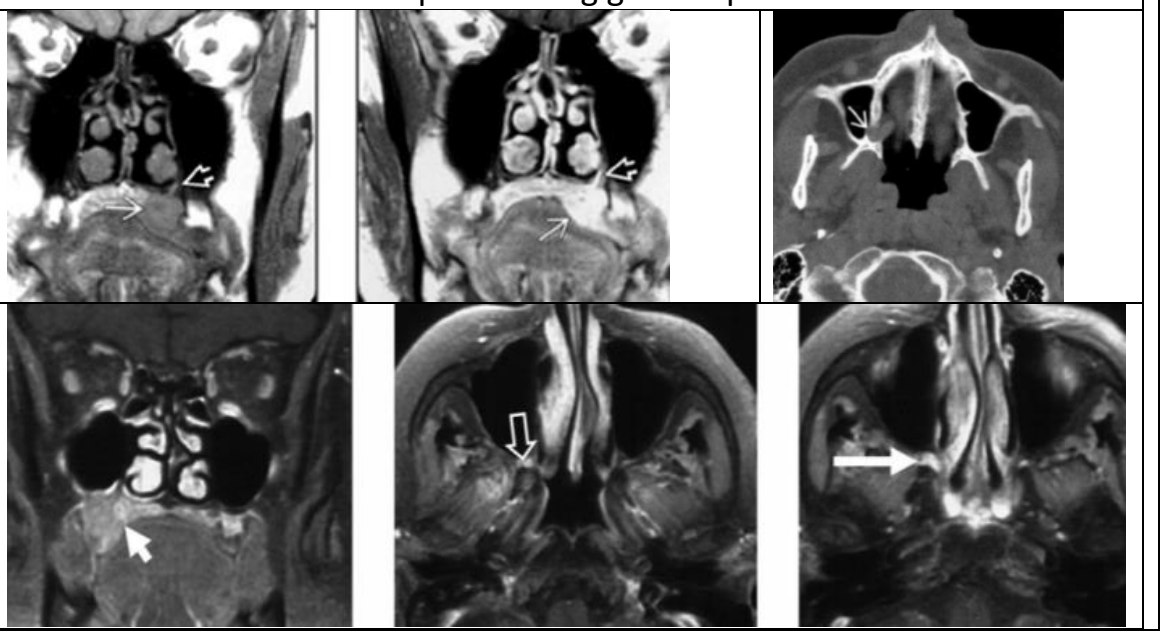
Floor of mouth ms invasion	Mylohyoid muscle invasion	Submandibular duct dilatation



6) Hard Palate

Malignant minor salivary gland tumor
Most common location is hard palate-soft palate junction
Sagittal and coronal images
Spread laterally => invade the maxillary alveolar ridge
Spread superiorly => involve the nasal cavity and maxillary sinuses
Perineural spread => along greater and lesser palatine nerves => Pterygopalatine fossa.

Hard Palate => Perineural spread along greater palatine nerve



Mandible

I.	Cystic
II.	Sclerotic
III.	Ground glass
IV.	Mixed lytic & Sclerotic
V.	Lytic = Malignant

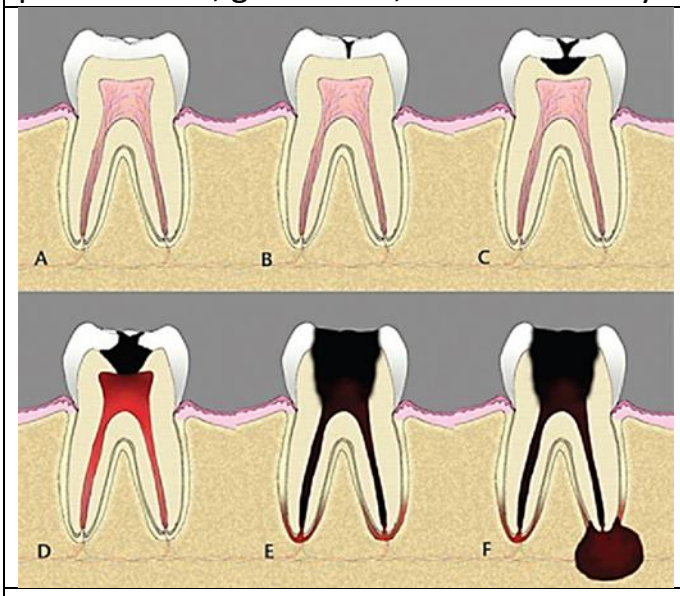
I. Mandibular Cystic Lesions

A- Odontogenic Mandibular Cystic Lesions

1) Periapical Cyst

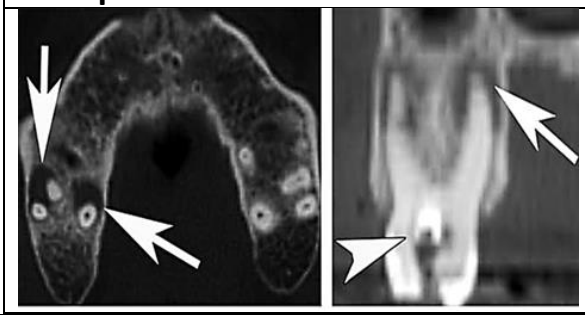
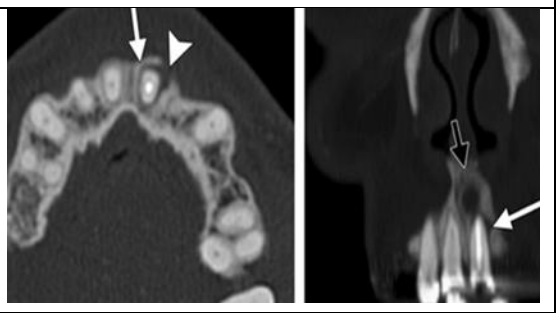
Most common odontogenic cyst
Results from inflammation secondary to caries or other entities.

Infection spreads to the apex (root) of the tooth => secondary apical periodontitis, granuloma, or abscess => cyst formation



<u>Periapical Lucency</u>

- Periapical Periodontitis
- Periapical Granuloma
- Periapical Cyst
- Periapical Abscess

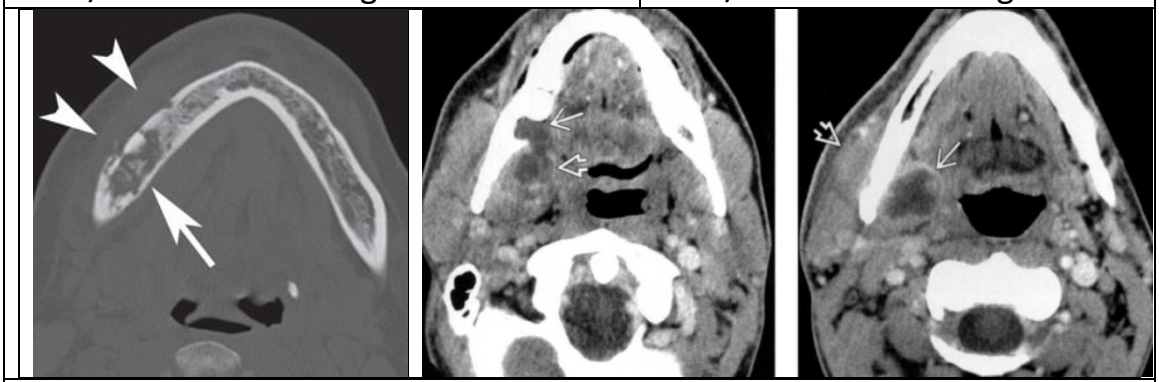
Periapical lucency = **Periapical Periodontitis =** **Periapical Granuloma**	**Periapical Cyst =** **Periapical Abscess**
	

Complications of Apical Periodontitis

- Acute osteomyelitis
- Chronic osteomyelitis
- Extra-osseous Abscess Formation
- Odontogenic Sinusitis
- Facial cellulitis & Abscess
- Ludwig Angina
- Pre or post- septal orbital cellulitis
- Ophthalmic or facial vein septic thrombosis
- Cavernous sinus thrombosis

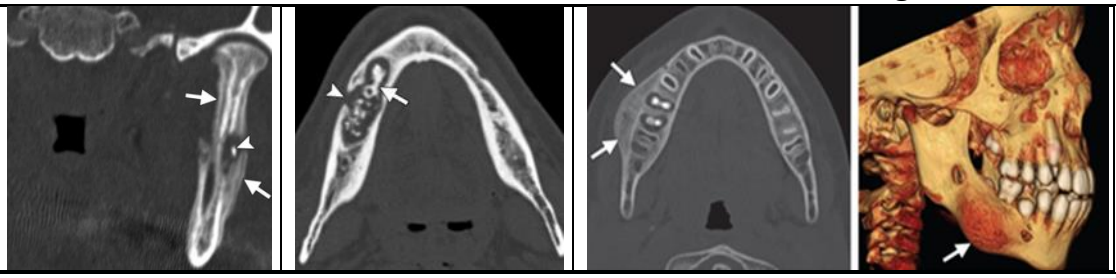
Odontogenic Osteomyelitis

Causes:	**Risk factors:**
Dental caries Dental extractions Dental or mandibular fractures Osteoradionecrosis Hematogenous spread of infection.	Diabetes mellitus Alcoholism Malnutrition Sickle cell disease Collagen vascular diseases Radiation therapy
a) Acute Osteomyelitis: Peri-apical lucency Ill defined osteolytic lesion Cortical disruption Periosteal reaction Soft-tissue inflammatory changes Smudging of fat planes Skin / Fascial thickening	**b) Sublingual / Submandibular Space Abscess:** Central necrosis Marginal enhancement Soft-tissue inflammatory changes Smudging of fat planes Skin / Fascial thickening



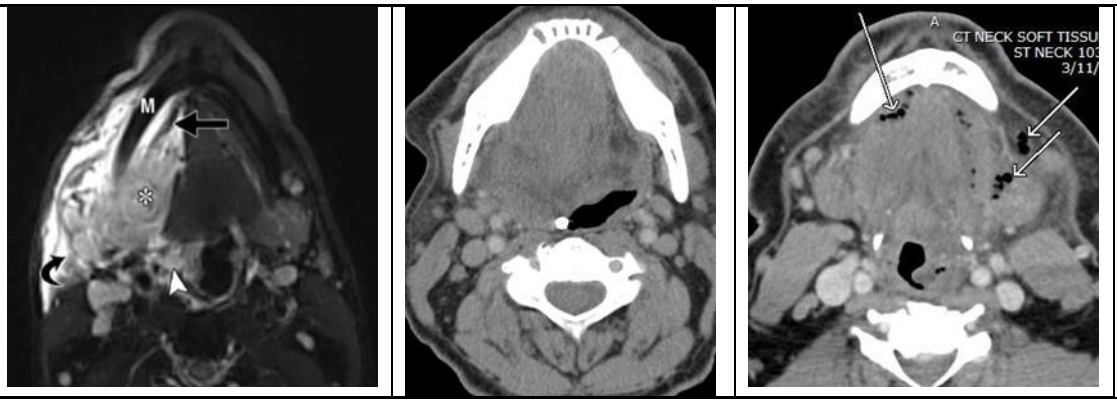
c) Chronic Osteomyelitis:

Sclerotic sequestrum
Surrounding low-attenuation zone
Sinus tract through the buccal lingual cortex.
Periosteal new bone formation “Lamellated = onion skinning”



d) Ludwig Angina

Serious, life-threatening infection of the floor of the mouth that rapidly extends bilaterally to the soft tissues of the oral cavity.
Complication of odontogenic infection.
Cellulitis – No abscess.

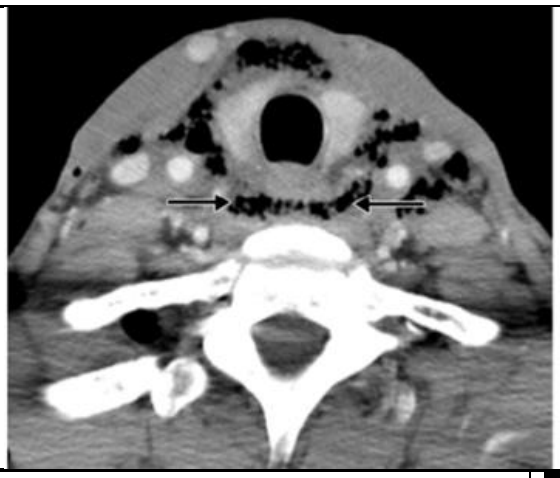


e) Descending Necrotizing Mediastinitis

Rare but emergent complication of odontogenic infection.
Infection spreads from the oral cavity or oropharynx to the mediastinum by way of the retropharyngeal space (“danger” space).

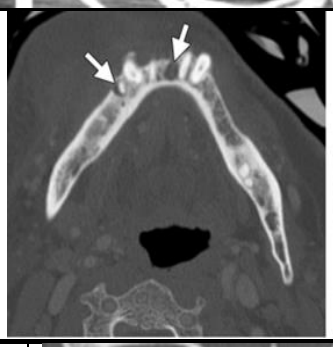
Radiological features:

Mediastinal fluid collections + Gas loculi
Smudging of mediastinal fat.
Pericardial or pleural effusions



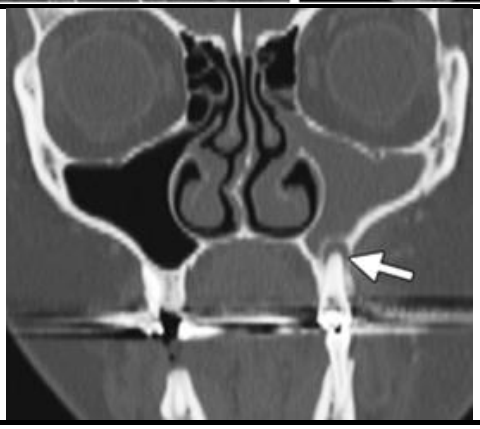
f) Facial Cellulitis + Abscess

Central necrosis
Marginal enhancement
Soft-tissue inflammatory changes
Smudging of fat planes
Skin / Fascial thickening



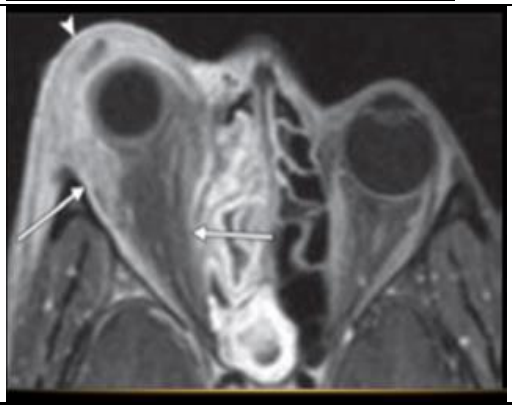
g) Odontogenic Maxillary Sinusitis

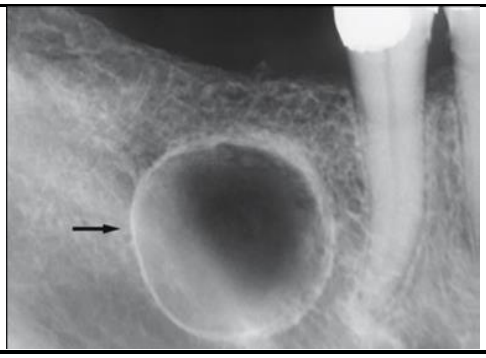
Mucosal thickening
Retained secretions
Air/Fluid level



h) Pre-septal Cellulitis = Peri-orbital Cellulitis

i) Pre + Post-septal Cellulitis = Periorbital + Orbital Cellulitis

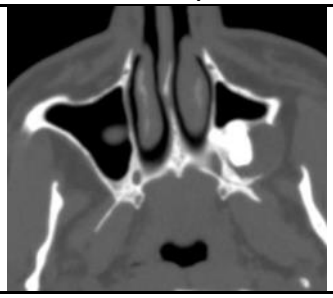


j) Ophthalmic Vein Thrombosis	**k) Cavernous Sinus Thrombosis**
2) Residual Cyst	
Periapical cyst which is retained in jaw after removal of associated tooth	

B- Mandibular Cytsic Lesions with Impacted Tooth

1) Dentigerous Cyst

- 2nd most common odontogenic cysts.
- Mandibular 3rd molar (most common)
- Maxillary 3rd molar (2nd most common
- Centered on an impacted or unerupted tooth

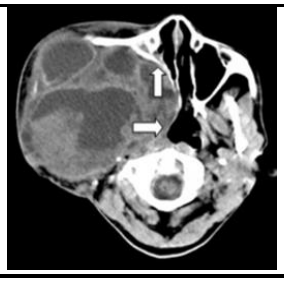
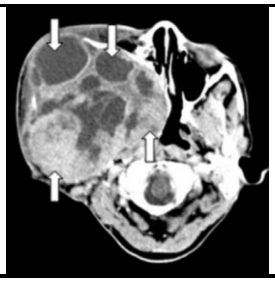


2) Odontogenic keratocyst

- Cystic benign tumor
- associated with an impacted tooth
- Multiple KCOTs is associated with Gorlin-Goltz syndrome

3) Ameloblastoma

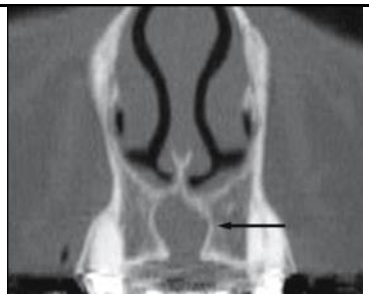
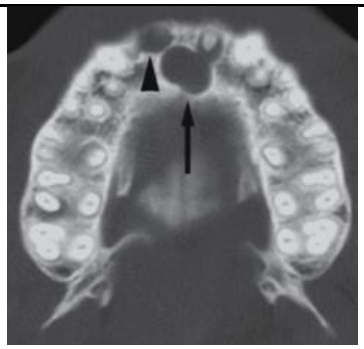
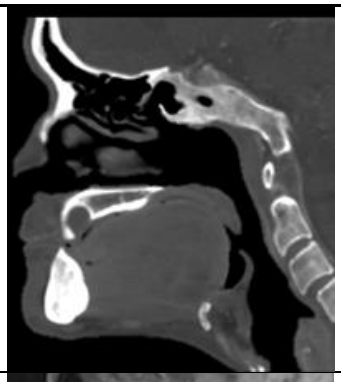
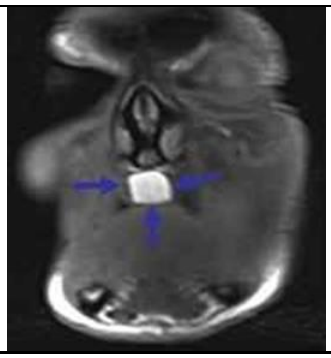
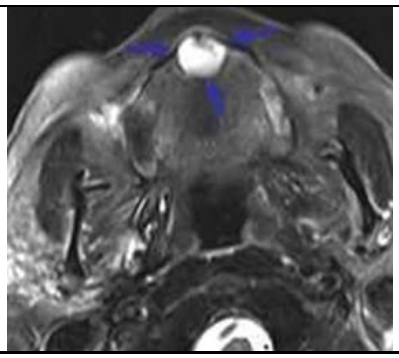
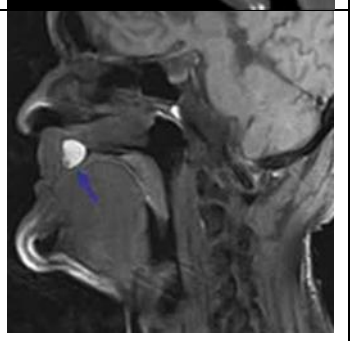
- Locally aggressive tumor
- 3rd molar tooth
- Mandible (80%) - Maxilla (20%)
- Associated with unerupted tooth
- Multilocular + Soap bubble appearance
- Mixed solid and cystic lesion

C- Non-Odontogenic mandibular Cystic Lesions

1) Nasopalatine / Incisive Canal Cyst

Cyst arising from epithelial residues in nasopalatine (incisive) canal.
Location: Anterior midline maxilla.

2) Stafne Cysts

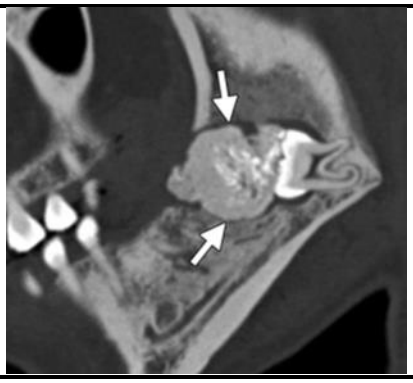
- Not cysts = not contain any fluid.
- They represent cortical defects near the angle of the mandible below the inferior alveolar canal.
- Filled by part of the submandibular gland or adjacent fat.

II. Mandibular Sclerotic Lesions

Tooth related	Non-tooth related
Periapical = Cementoblastoma **Pericoronal = Odontoma**	**Osteoma** **Tori & Exostoses**

1) Odontoma

Most common odontogenic tumor.
Obstruct tooth eruption.
Age = children.
Pericoronal sclerotic lesion
Sharply marginated lesion
Low-attenuation halo.
Associated with an impacted tooth.

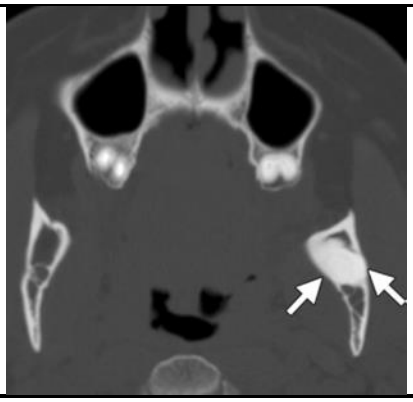


2) Cementoblastoma

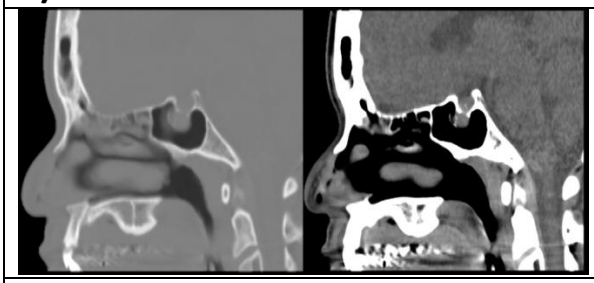
Rare benign periapical lesion
Age = Children and young adults
Location: Mandible Molar and premolar region.
Periapical sclerotic lesion
Sharply marginated lesion
Low-attenuation halo.
Directly fuse to root of tooth

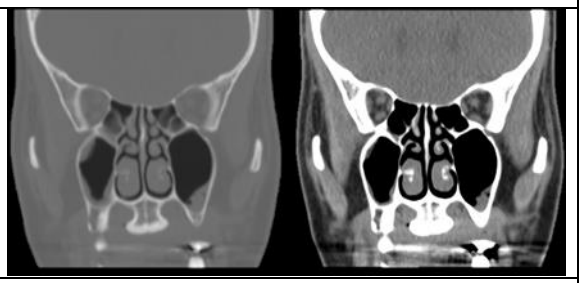
3) Osteomas

Benign tumors composed of mature compact or cancellous bone.
Sclerotic non–tooth-related lesions.
No perilesional halo.
Multiple osteomas associated with Gardner syndrome

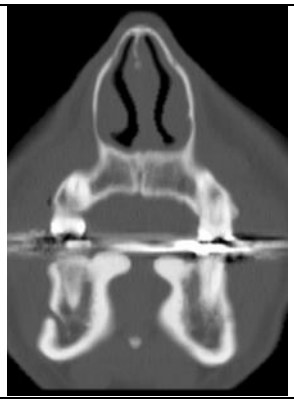


4) Torus Palatinus





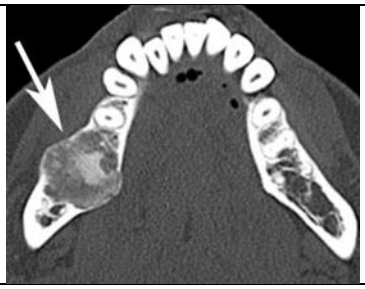
5) Torus Mandibularis



6) Torus Maxillarus

III. Mandibular Ground Glass Lesions

1) Ossifying Fibroma

Subtypes: Cementifying Fibroma Cemento-ossifying Fibroma Juvenile Ossifying Fibroma	Age = 3rd – 4th decades Sex: F>M
<u>Radiological Features:</u> Solitary unilocular well-defined Focally expansile lesion Ground-glass attenuation	

2) Fibrous Dysplasia

Monostotic FD (More common) Polystotic FD: 3 subtypres: • Craniofacial FD • Lichtenstein-Jaffe FD • Albright syndrome.	

3) Renal Osteodystrophy

Renal insufficiency and secondary hyperparathyroidism Diffuse ground-glass attenuation Loss of definition of the cortex, lamina dura, and wall of the inferior alveolar nerve canal Brown tumor = osteitis fibrosa cystica	

IV. Mixed Lytic & sclerotic Mandibular lesions

1) Osteoradionecrosis

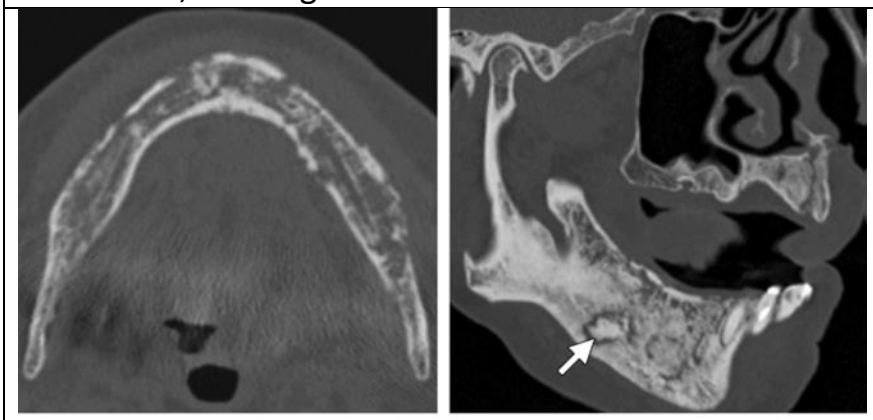
Radiation therapy to the head and neck develop bone necrosis secondary to hypoxia, hypovascularity, hypocellularity, and fibrosis

Radiological Features:

Marked sclerosis with a loss of trabeculation in spongiosa
Cortical interruptions
Bone fragmentation or sequestration
Areas of gas attenuation in bone

2) Bisphosphonate-related Osteonecrosis of the Jaw (BRONJ)

associated with the use of oral or intravenous bisphosphonates to treat various bone conditions such as osteoporosis, multiple myeloma, metastasis, and Paget disease



3) Mandibular Osteomyelitis

V. Malignant Lytic Destructive Mandibular Lesions

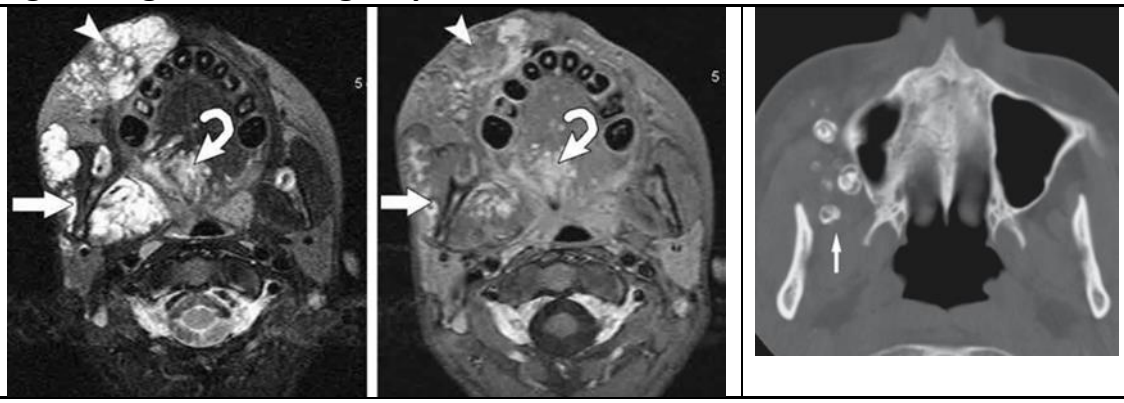
- **Secondary to invasion from the surrounding mucosa:**
  - Squamous cell carcinoma
  - Adenoid cystic carcinoma
  - Mucoepidermoid carcinoma
- **Primary carcinomas:**
  - Odontogenic carcinoma
  - Primary intraosseous carcinoma
  - Malignant ameloblastoma.
- **Sarcoma:**
  - Osteosarcoma
  - Chondrosarcoma
  - Fibrosarcoma
- **Leukemia – Lymphoma**
- **Metastasis – Multiple Myeloma – Plasmacytoma**

Trans-spatial

Trans-spatial Lesions
1) Vascular lesions 2) Aggressive tumors 3) Infections

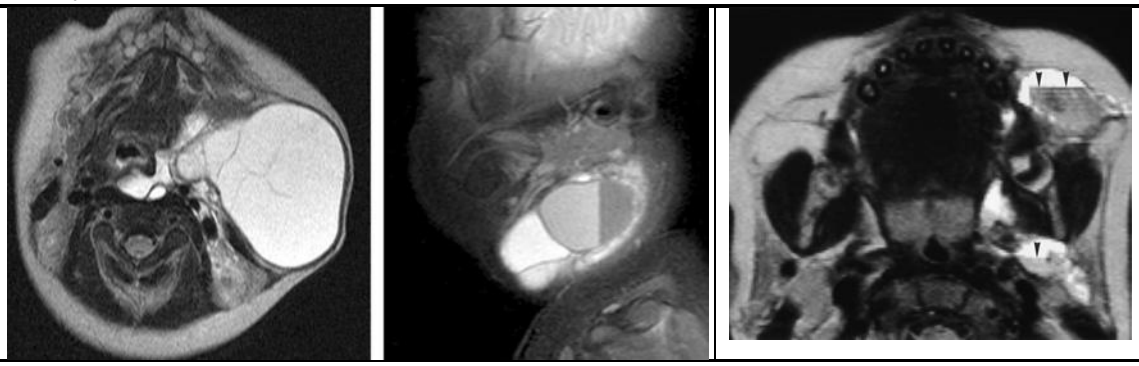
Venous Malformation

Low flow malformation
High T2 signal + Low signal phleboli



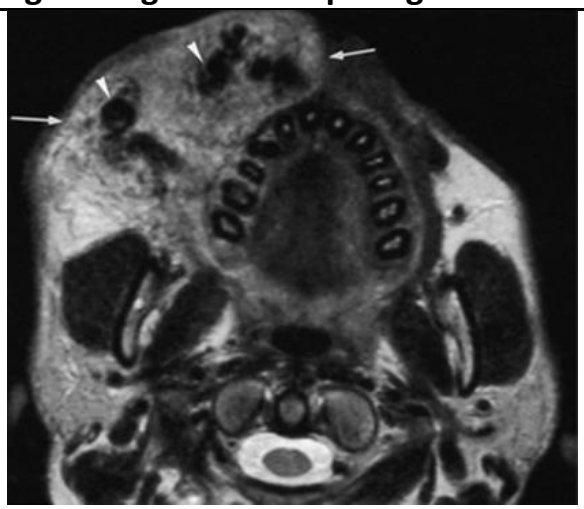
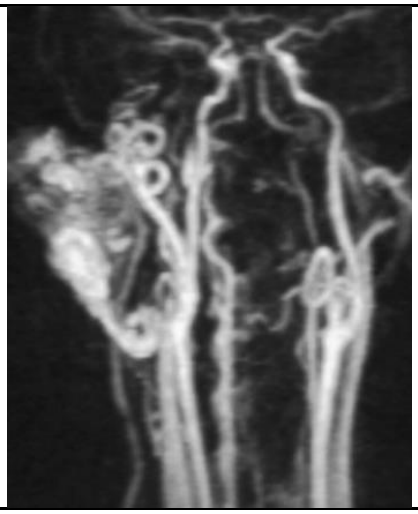
Lymphatic Malformations

Multilocular cystic lesion
Fluid / fluid level



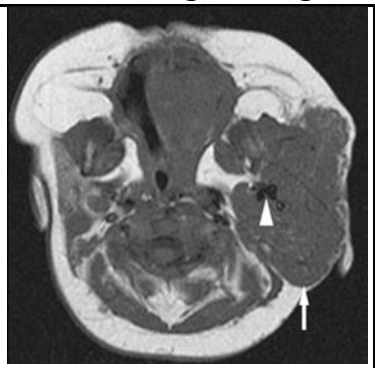
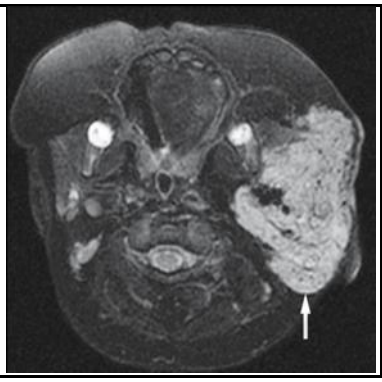
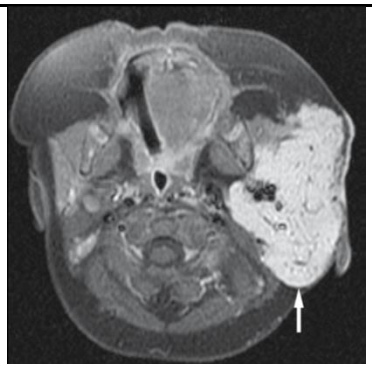
AVM

High T2 signal + Multiple signal flow voids

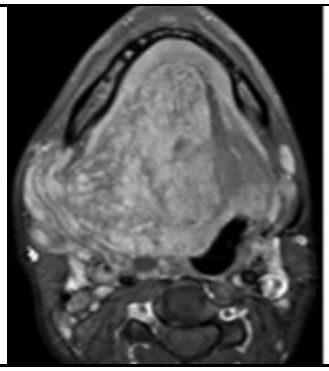
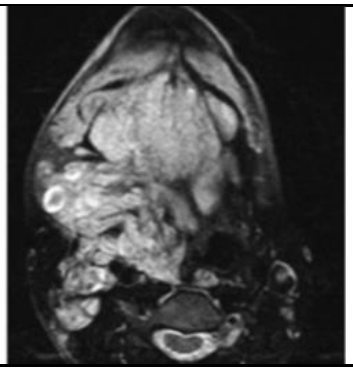
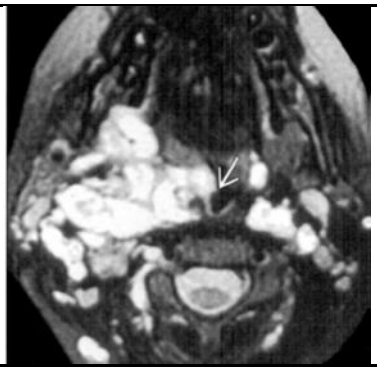



Infantile Capillary Hemangioma

Ill defined High T2 signal + marked enhancment

Plexiform Neurofibromatosis

Cervical LNs

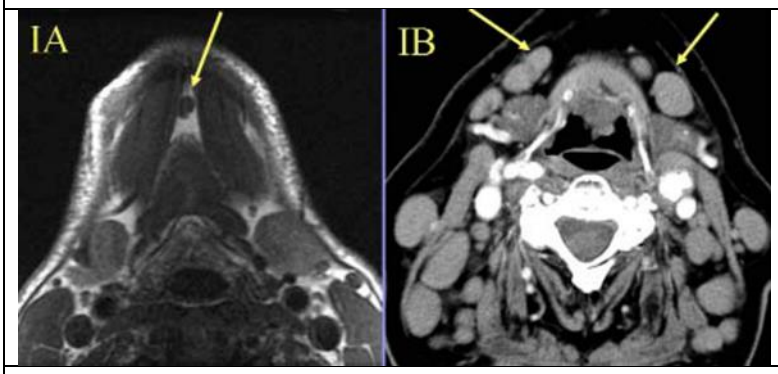
Vertical Chain of LNs

IA Submental
IB Submandibular
II High Jugular Chain
III Mid Jugular Chain
IV Low Jugular Chain
V Posterior Triangle
VI Superior mediastinal

Level I

Underneath the mandible
Above the hyoid bone

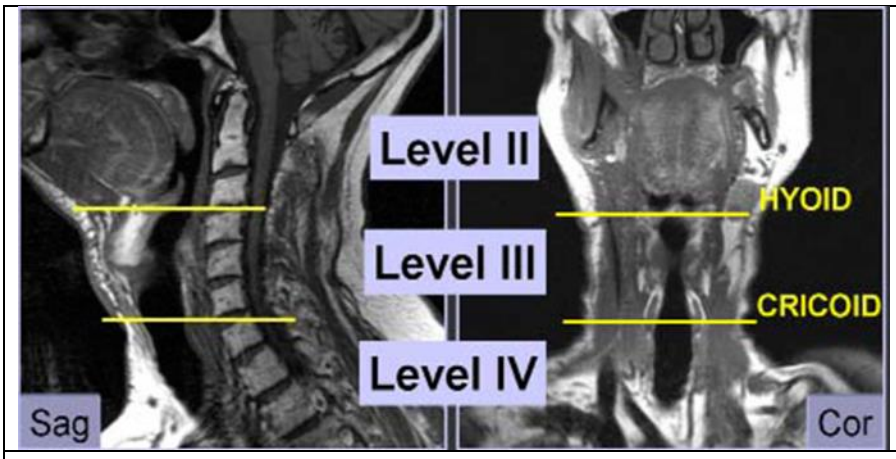
- IA – Submental LNs between anterior bellies of digastric muscles
- IB – Submandibular LNs anterior to submandibular gland



Level II, III & IV

LNs along IJV.
LNs anterior to posterior border of sternomastoid muscle.

- High (II) skull base – hyoid
  - IIA = Anterior, medial, lateral or posterior and touching IJV
  - IIB = Posterior and separate by fat plane from IJV, but anterior to posterior border of sternomastoid muscle
- Mid (III) Hyoid – cricoid
- Low (IV) Cricoid – thoracic inlet



Level V

LNs behind posterior border of the sternomastoid muscle
LNs in posterior cervical space

- Level VA = Above the cricoid cartilage
- Level VB = Below the cricoid and above the clavicle

Level VI

Pre-laryngeal and pre-tracheal LNs
Delphic LNs
LNs in the visceral compartment
from the hyoid bone superiorly
to the suprasternal notch inferiorly.
The lateral border is formed by the medial border of the carotid sheath.

Level VII

Superior mediastinal LNs
Below suprasternal notch
Above brachiocephalic vein

Horizontal Chain of LNs

Parotid LNs: from skin carcinoma, parotid primary
Facial LNs: superficial facial soft tissues, including occipital, mastoid, etc.
Retropharyngeal LNs: only in the suprahyoid neck
Supraclavicular LNs: immediately above the clavicle

Malignant LN

Size => Longest diameter:

> 1cm other LNs

> 1.5cm for level I & II

> 0.8cm for retropharyngeal LN

Shape: kidney shaped => rounded or oval

Central necrosis

Extracapsular (perinodal) extension

US: Thickened cortex >3mm + Effaced hilum

Positive PET

AJCC Nodal Staging

N0 - No metastatic nodes

N1 - Single ipsilateral, < 3 cm

N2

- N2a - Single ipsilateral, > 3 cm < 6 cm
- N2b - Multiple ipsilateral, < 6 cm
- N2c - Bilateral or contralateral, < 6 cm

N3 - Node or nodes > 6cm

Calcified LNs

- Mycobacterium,other infections
- Sarcoidosis
- Papillary ca thyroid
- Mets: breast, lung, colon
- Treated lymphoma

Perineural Spread In Head And Neck Tumours

Tumour infiltrating and extending along the perineurium to noncontiguous regions from the 1ry tumor site

The incidence of perineural tumour spread = 2.5 to 5.0%

Centripetally spread towards the brain
Centrifugal spread towards branches

Tumors:

Adenoid cystic carcinoma
Squamous cell carcinoma
Mucoepidermoid carcinoma
Benign or malignant nerve sheath tumors
Meningioma - Lymphoma – Melanoma

Nerves:

The maxillary and mandibular divisions of the trigeminal n.: most common
The facial nerve: most common.
The ophthalmic division of the trigeminal nerve
The hypoglossal nerve: less frequently involved

Perineural spread along the maxillary nerve

- Cutaneous tumours arising from the facial region
- Oropharyngeal neoplasms
- Sinonasal neoplasms.
- Any tumor reaching pterygopalatine fossa => F. Rotundum

Perineural spread along mandibular nerve (Inferior alveolar n – Lingual n)

- Masticator space tumours
- Submandibular gland tumors
- Tongue tumors
- Floor of mouth tumors

Perineural spread along the facial nerve

- ❖ Parotid gland tumors

Radiological Features:

1ry Imaging Features:

CT: -Obliteration of fat
- Widening/erosion/destruction of foramina

T1: Obliteration of fat
T2 FS: Thickening + High signal of the nerve
T1 +C Fat Sat: Thickening + Enhancements of the nerve.

2ry Imaging Features => Muscle denervation:

- ❖ Acute/Subacute phase = Edema phase:
  - o T2:Hyperintense
  - o T1+C: Contrast enhancement.
- ❖ Chronic phase = Fatty atrophy:
  - o T1 & T2: Hyperintense signal + Atrophy
  - o T1+C: NO enhancement.
- ❖ Tumor lesions at some distance form 1ry site in neural cross roads (eg: Pterygopalatine fossa & Meckel's cave)

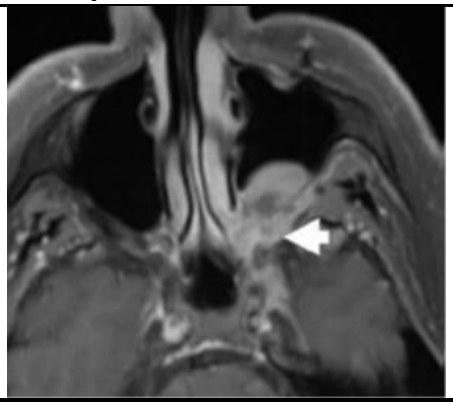
Pterygo-palatine fossa Invasion:

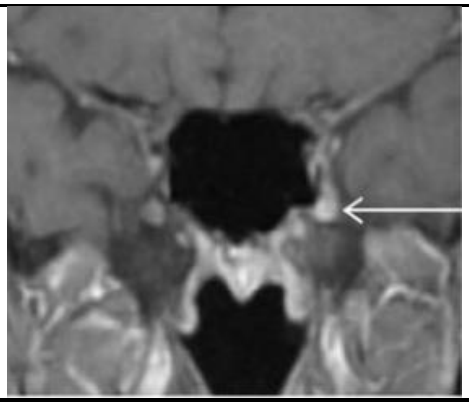
- ❖ T1: Replacement of high T1 fat signal by intermediate tumor signal
- ❖ +C: Enhancing soft tissue
- ❖ CT: Pterygoid plates => Cortical destruction – Medullary invasion.

Cavernous sinus involvement:

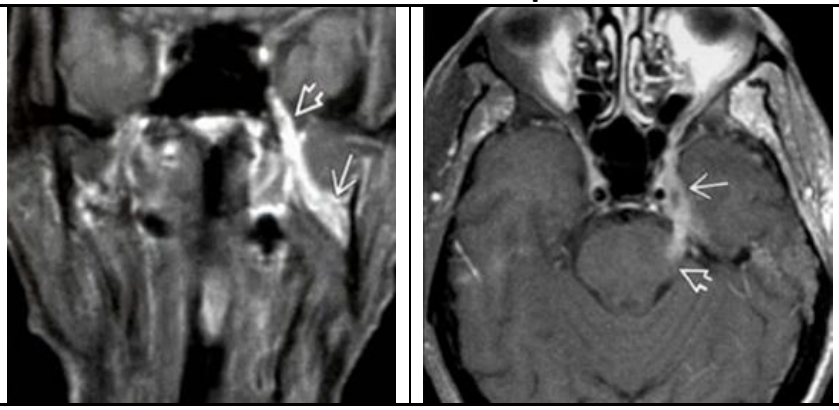
- ❖ Cavernous sinus enlargement
- ❖ Convexity of lateral dural margin
- ❖ T2: Replacement of high venous signal by intermediate tumor signal
- ❖ Neoplastic encasement of ICA

Perineural tumour spread along the maxillary nerve
Pterygoplatine fossa => F.Rotundum => Cavernous sinus => Meckel's cave => Prepontine cistern => Pons

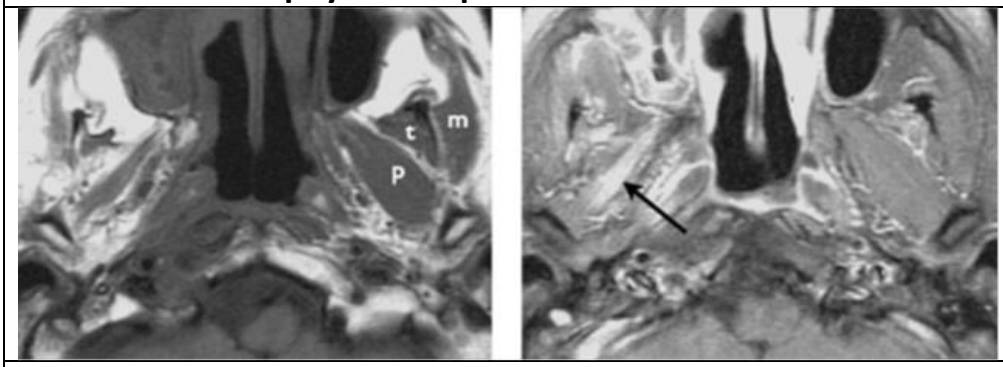




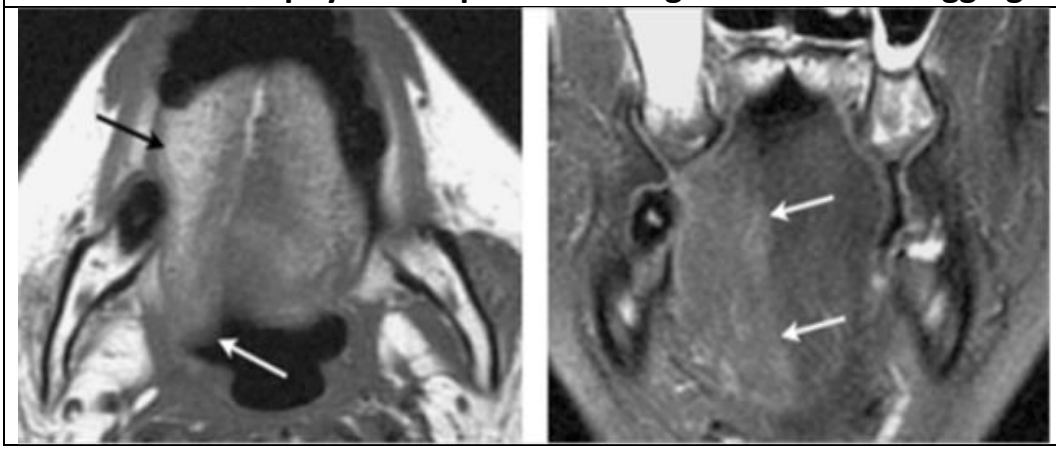
Perineural tumour spread along the mandibular nerve
=> F.Ovale => Meckel's cave => Prepontine cistern => Pons



Perineural tumour spread along the mandibular nerve =>
Denervation atrophy of the ipsilateral masticator muscles



Perineural tumour spread along the hypoglossal nerve =>
Denervation atrophy of the ipsilateral tongue + Posterior sagging



Petrous Bone

List of Contents
External ear
Middle ear
Inner ear
Facial nerve
Petrous apex
CPA / IAC
Jugular Foramen
Petrous Trauma
SNHL

Petrous Technique

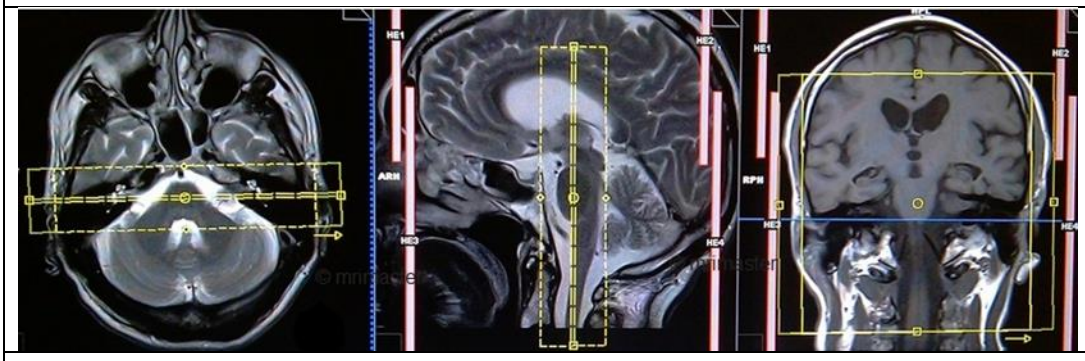
CT Protocol

Axial & Coronal Bone Window
Axial & Coronal Soft tissue window

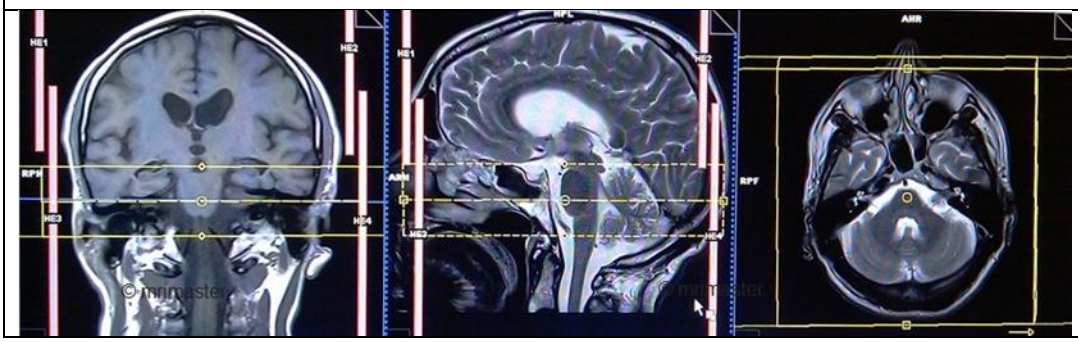
MRI Protocol

Axial T2 of the brain	Head coil
	FOV = 16 – 18 cm
Axial T1	Slice thickness = 3mm
Axial 3D CISS/FIESTA/SPACE	Slice gap = 0.5 mm
	From sphenoid sinus to 4th ventricle
Coronal T1	From top of petrous bone to base of
Coronal T2 FS	mastoid process
	Coronal
Post contrast	// IAC
Axial T1 FS	**Axial**
Coronal T1 FS	// IAC
Axial DWI	⊥ Brain stem

Coronal

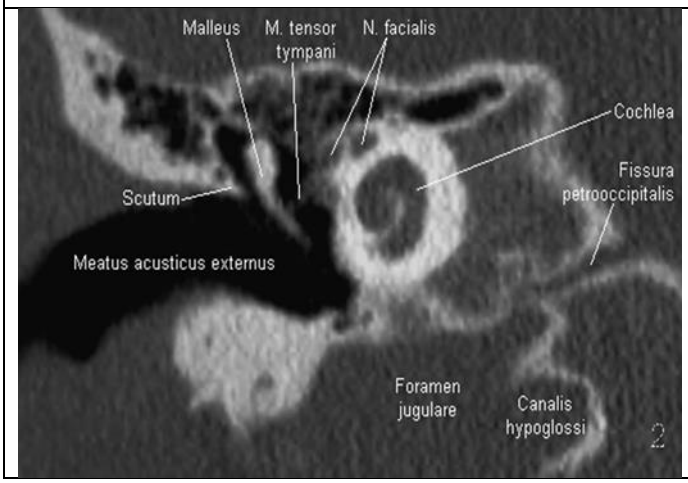


Axial



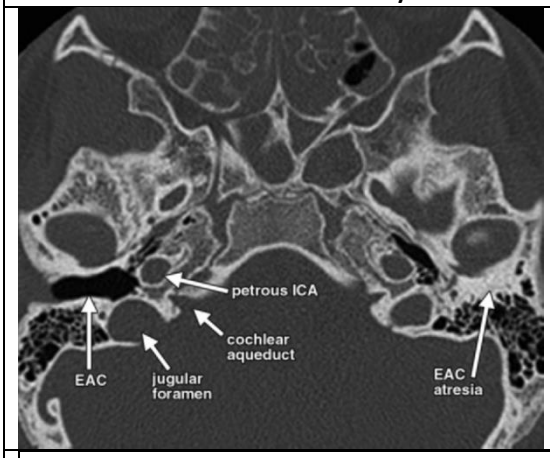
Petrous Bone

I. External Ear

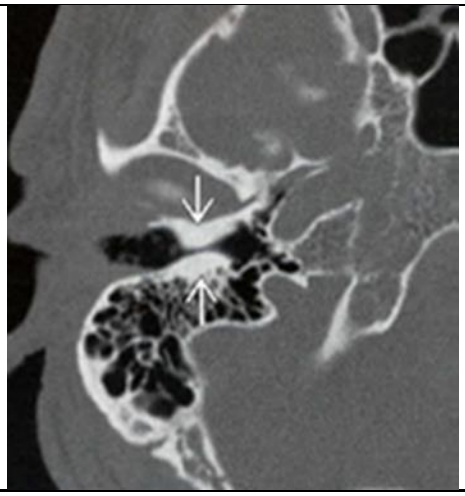
Anatomy:
<u>External Auditory Canal :</u> Tympanic bone medially Fibrocartilage laterally **<u>Tympanic Membrane</u>** Attached by tympanic annulus **<u>SCUTUM</u>** Antrosuperior tympanic annulus


❖ EAC ATRESIA

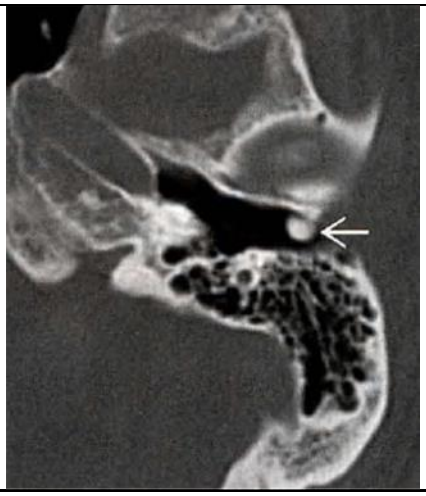
- Microtia = Small, dysmorphic pinna
- Bony, soft tissue, or mixed stenosis of entire EAC
- Small middle ear cavity
- Ossicular fusion & rotation
- Oval window atresia.
- Congenital cholesteatoma behind atresia plate (10%)
- Aberrant course of tympanic & mastoid portions of facial nerve.
- Inner ear & lAC usually normal



EAC EXOSTOSES = Surfer's Ear



EAC OSTEOMA



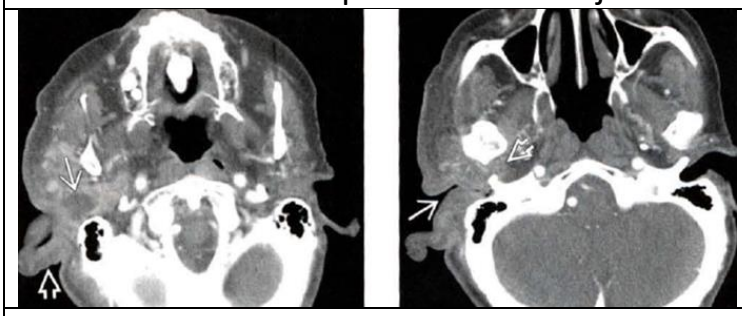
❖ Bone Destructive Lesions

1) Malignant Otitis Externa

Severe infectious disease involving EAC and adjacent soft tissues.
Elderly diabetic patients.
Pseudomonas aeruginosa infection.
EAC & auricle soft tissue with diffuse heterogeneous enhancement.
Bony erosion
Cellulitis = Adjacent soft tissues show heterogeneous enhancement.
Abscess = rim-enhancing fluid seen in adjacent soft tissues.

<u>Spread of Infection:</u>

- Inferior: Parotid, masticator & parapharyngeal spaces
- Posterior: Into mastoid air cells
- Medial: Into middle ear cavity/petrous apex
- Anterior: Into temporomandibular joint

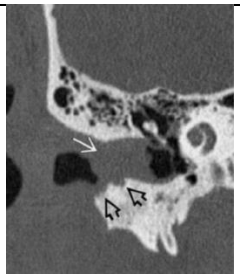


2) EAC Congenital Cholesteatoma = Epidermoid

Location: Commonly posterior & inferior EAC wall
Erosive EAC soft tissue mass
Bone fragments commonly found within mass (50%)
No Enhancement.

3) EAC SCCa

EAC lesion
Heterogeneously enhancement
Underlying bony destructive change
Pre & post-auricular, parotid malignant LNs.



Petrous Bone

II. Middle Ear

❖ Anatomy:

3 parts:

A. <u>Epitympanum:</u>

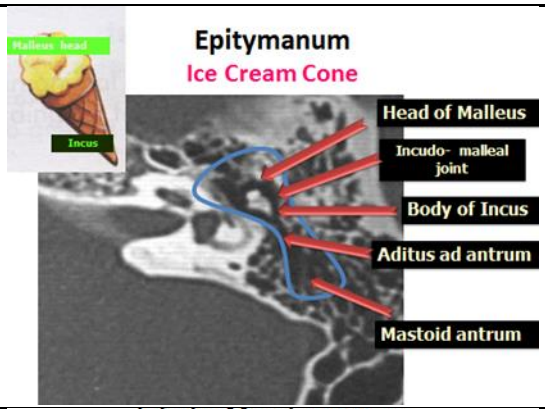
Middle ear above line from scutal tip to tympanic segment of CN7

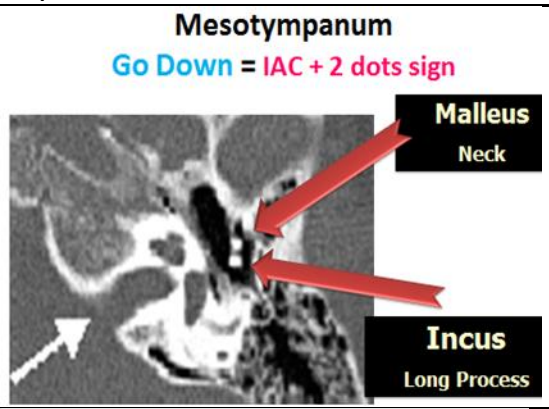
B. <u>Mesotympanum</u>

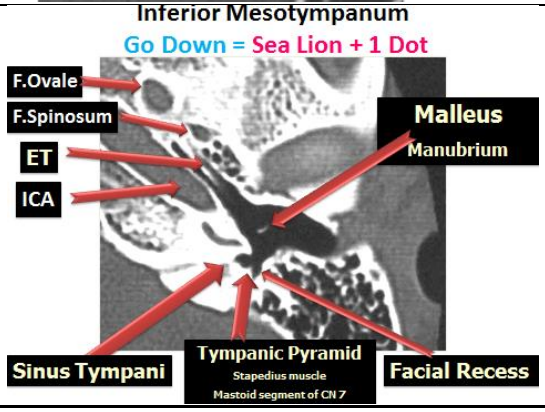
Posterior wall	Medial wall:
Facial Nerve Recess Pyramidal Eminence Sinus Tympani	Lateral Semicircular Canal, Tympanic Segment CN7, Oval Window Round Window

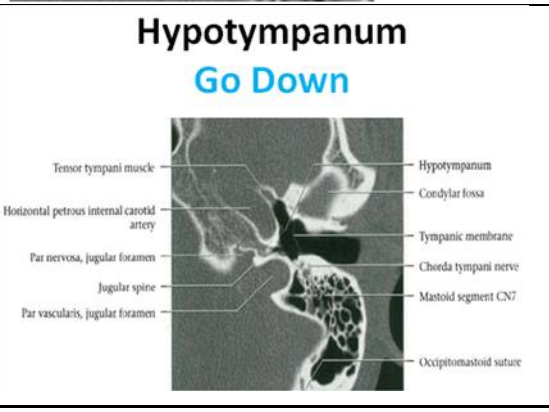
C. <u>Hypotymanum:</u>

Middle Ear Ossicles: Malleus – Incus - Stapes





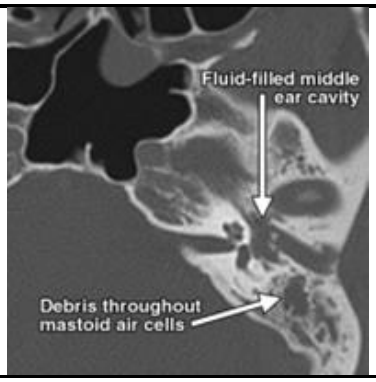




❖ Acute Otitis Media / Otomastoiditis

Children: common.
Adults: less common – Nasopharyngeal Carcinoma.
Active infection in middle ear & mastoid air cells.

Opacification of middle ear & mastoid air cells with fluid attenuation.
No ossicular disruption.
No bon erosion.

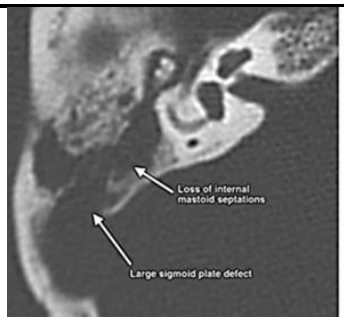


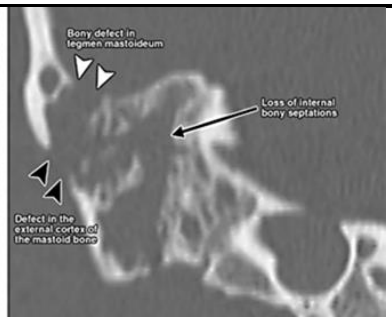
Complications:

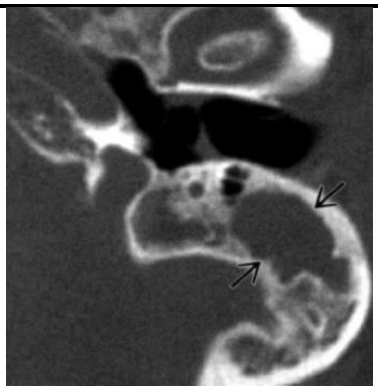
1) Acute coalescent otitis media (ACOM)
2) Subperiosteal abscess
3) Meningitis & brain abscess
4) Sigmoid sinus thrombosis/thrombophlebitis (SST)
5) Bezold abscess.
6) Serous or suppurative labyrinthitis
7) Petrous apicitis

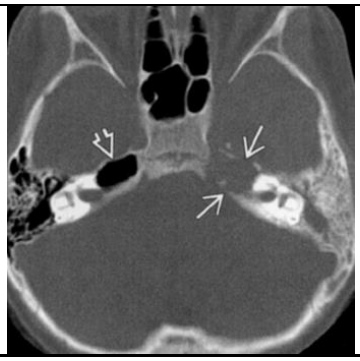
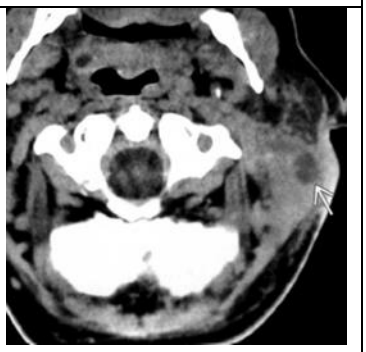
1) ACOM = Acute Coalescent Otitis Media:

Complete opacification of middle ear cavity & mastoid air cells with fluid-attenuation material
Loss of internal mastoid bone septa.
Erosions of sigmoid sinus plate + tegmen mastoideum + external cortex of the mastoid bone

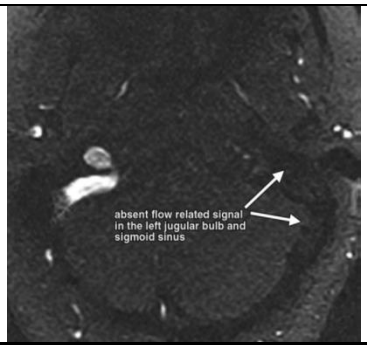
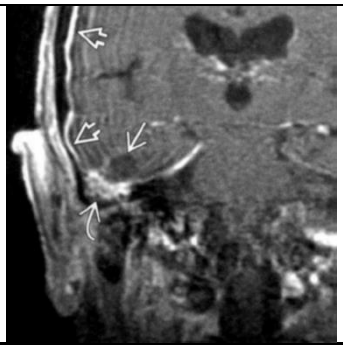




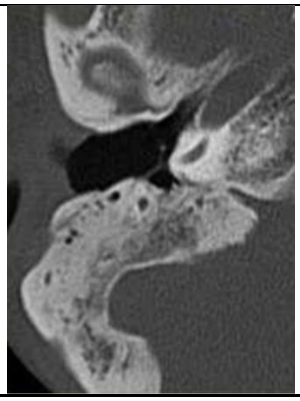
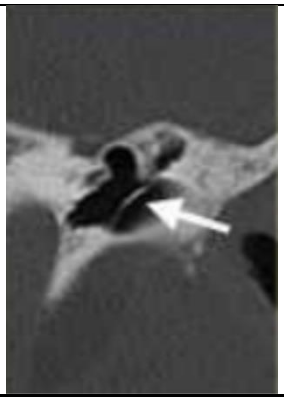


2) Petrous Apicitis	3) Post-auricular Abscess	4) Bezold Abscess
		

Intracranial Complications:

5) Sigmoid Sinus Thrombosis	6) Epidural Abscess	7) Meningitis + Temporal Lobe Abscess
		

Chronic Otitis Media

Sclerotic Mastoid	Thickened Ear Drum	Calcified Ear Drum
		

❖ ACQUIRED CHOLESTEATOMA

Chronic middle ear infection associated with tympanic membrane perforation.
Cl/P: Conductive hearing loss + purulent discharge from the ea

PARS FLACCIDA	**PARS TENSA**
Prussak's space Medial to attic wall Lateral to ossicles	Sinus tympani & Facial nerve recess Posterior middle ear cavity Medial to ossicles

Radiological features:
Ill defined non-defendant soft tssiue mass
T1: low signal
T2: High signal
T1+C: No enhancement or faint peripheral enhancement.
DWI: Restricted

Extensions:

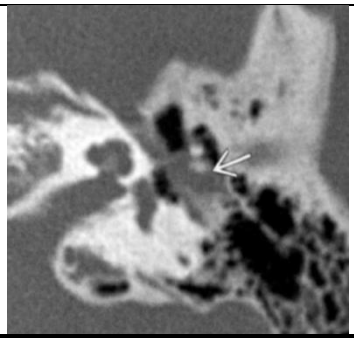
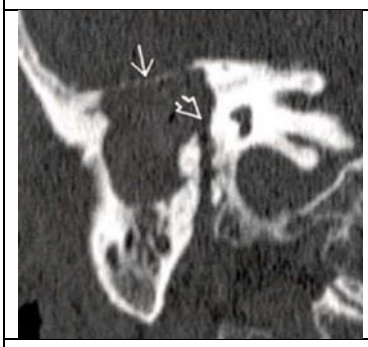
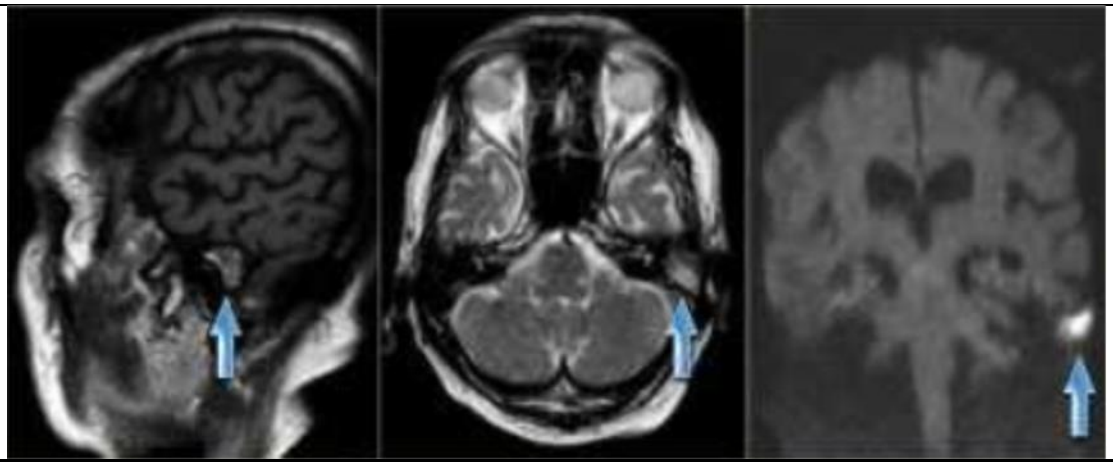
Posterolateral to aditus ad antrum => mastoid antrum
Inferior to posterior middle ear recesses
Mastoid air cells are underpneumatized and sclerotic

Erosions:

Scutum (early in Pars flaccida) Ossicles (early in Pars Tensa) Tegmen Tympani Lateral epitympanum wall	Facial canal => Fascial nerve palsy Lateral SCC => Perilymphatic fistula Oval window niche=>Perilymphatic fistula

Complications:

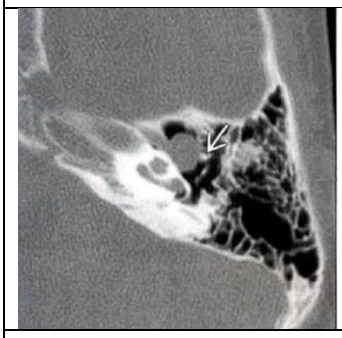
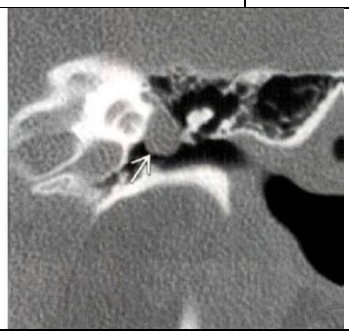
Labyrinthine fistula Fascial nerve palsy Petrous apex syndrome (Gradenigo's Syndrome)	Sinus thrombosis Meningitis Encephalitis Brain abscess

Pars flaccida => Scutum erosion	Pars tensa => Ossicular erosion	Erosion of Oval Window Niche
		
Erosion of Facial Nerve Canal	Erosion of Tegmen tympani + LSSC	
		
Restricted DWI		
		

DD: Cochlear Promontory Lesions

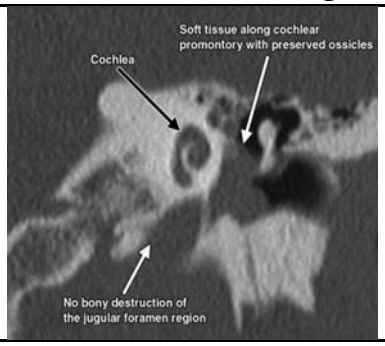
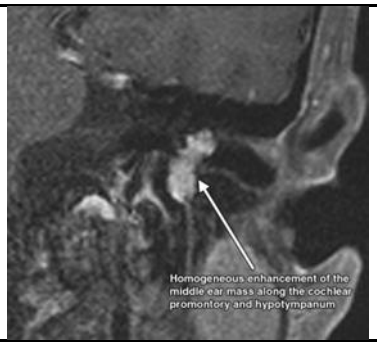
1) Congenital Cholesteatoma = Epidermoid

Well-circumscribed middle ear mass Over cochlear promontory NO ossicular erosions. Cochlear erosions	T1: low signal T2: moderately high signal **NO enhancement**

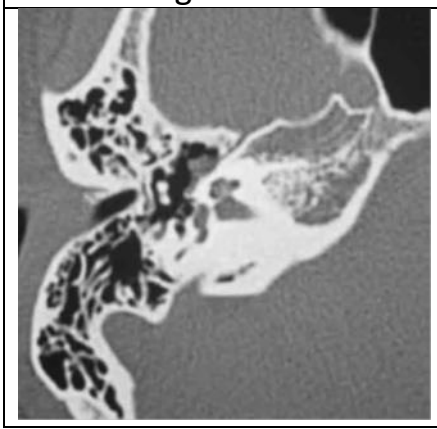
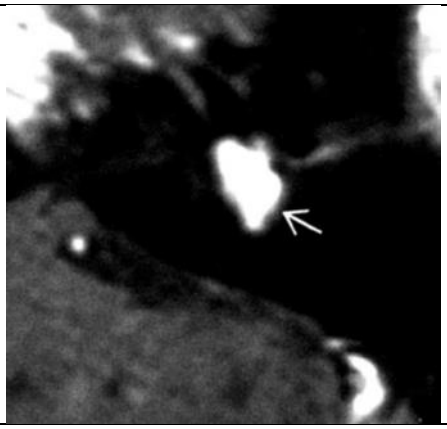
2) Glomus Tympanicum

Soft-tissue mass along the cochlear promontory and hypotympanum
T1+C: mass has homogeneous enhancement.


Soft tissue along cochlear promontory with preserved ossicles
Cochlea
No bony destruction of the jugular foramen region


3) MIDDLE EAR / FACIAL NERVE SCHWANNOMA

LOW T1 & HIGH T2 signal in middle ear	T1 C+ FS: enhancing mass in middle ear

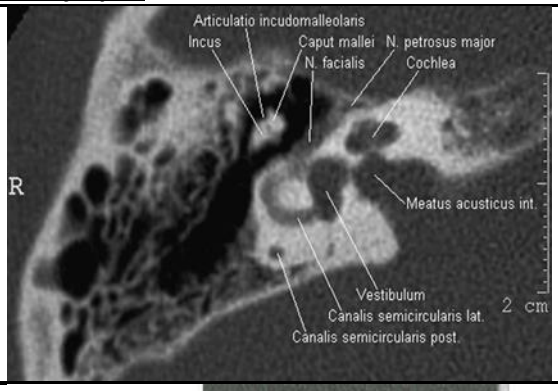



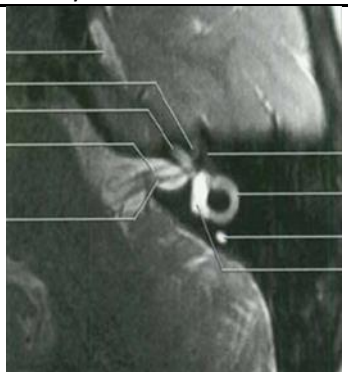
Petrous Bone

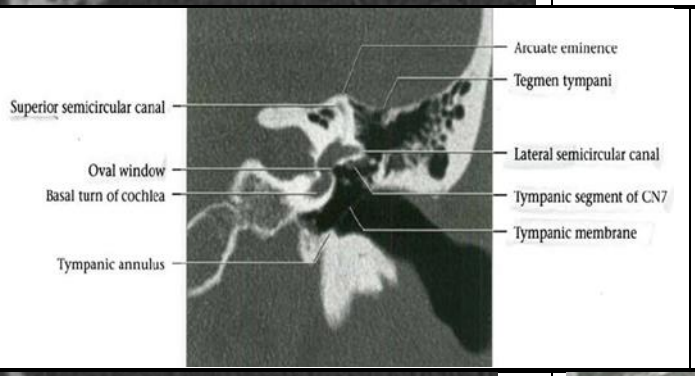
III. Inner Ear

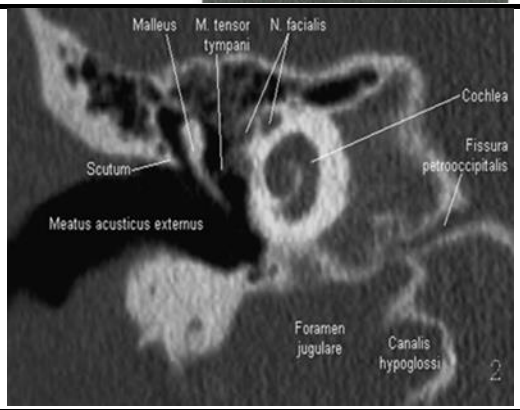
❖ Anatomy:

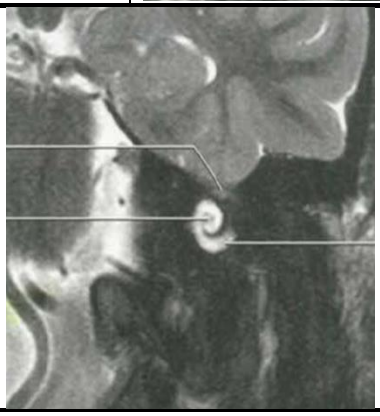
Bony Labyrinth: Bone confining cochlear, vestibule & semicircular canals
Membranous Labyrinth: vestibule (utricle & saccule), semicircular ducts, scala media of cochlea, endolymphatic duct & sac.
Perilymph: fluid within bony labyrinth that "bathes" endolymph-containing membranous labyrinth structures
Endolymph: fluid within structures of membranous labyrinth







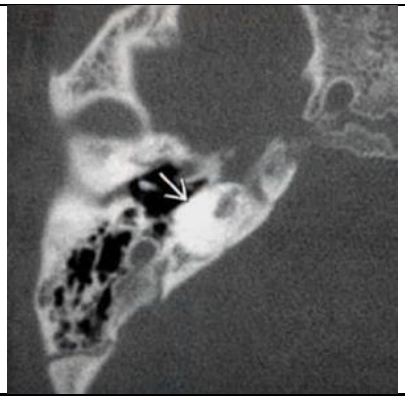




❖ Inner Ear Anomalies

1) LABYRINTHINE APLASIA = Michel Deformity

Complete absence of cochlea + vestibule + semicircular canals

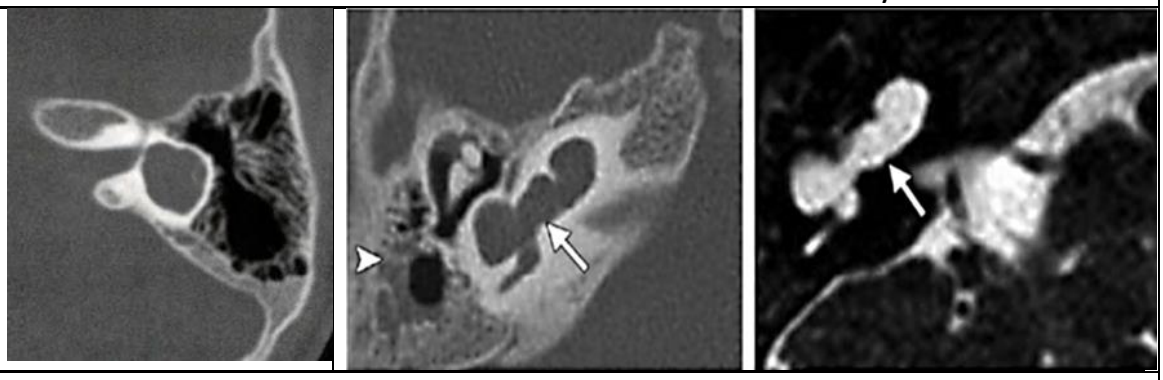


2) COCHLEAR APLASIA

Absent cochlea
Vestibule, SCCs & lAC are present
Malformed vestibule & SCCs

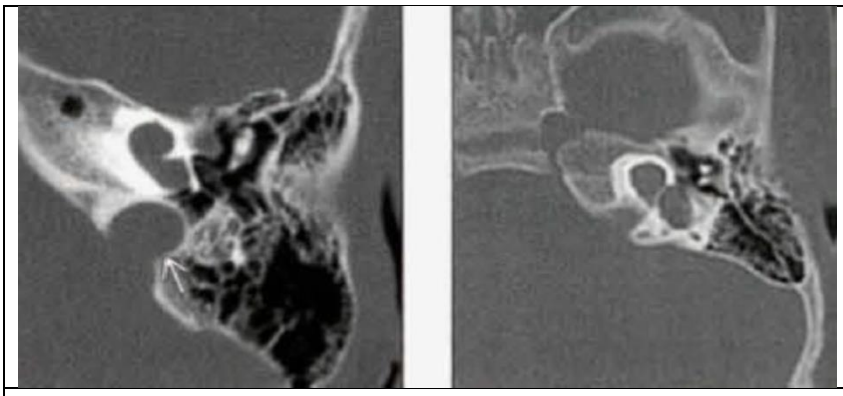
3) COMMON CAVITY

Confluence of Cochlea + Vestibule + SCC => Common Cavity



4) Type I Incomplete Partition Cystic Cochleovestibular Dysplasia

The modiolus is entirely absent
The cochlea has a cystic appearance + the vestibule is often dilated
=> "figure 8“ contour with no internal features



5) Type II Incomplete Partition Mondini Malformation

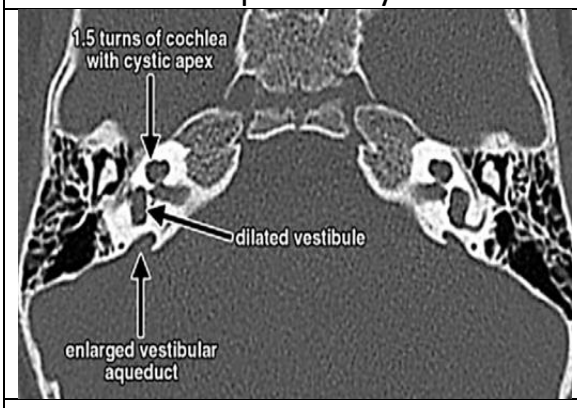
Triad of:

Abnormal cochlea

- Only 1.5 turns (instead of the normal 2.5 turns)
- Normal basal turn + cystic apex

Enlarged vestibule with normal semicircular canals

Enlarged vestibular aqueduct containing a dilated endolymphatic duct + sac = Vestibular Aqueduct syndrome



6) Semicircular Canal Dysplasia

Dilated lateral SCC forming single cavity with vestibule.

Posterior & superior SCC may be normal, dilated or hypoplastic.

Cochlea can be normal or incomplete apical & middle turn partition

7) Superior Semicircular Canal Dehiscence = Tullio's Syndrome

Thinning or absence of bony roof of superior SCCs.

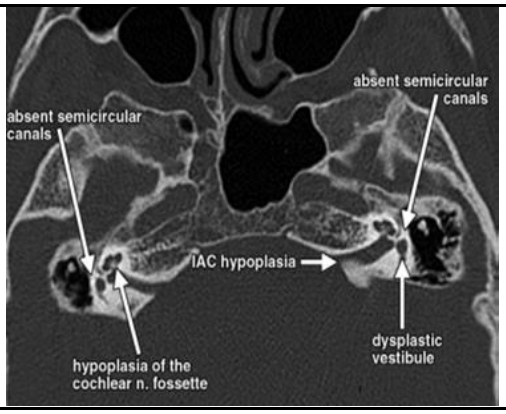
Bilateral

<u>Tullio phenomena:</u>

Sound induced dizzinnes - vertigo - upward & tortional nystagmus

8) CHARGE Syndrome

- Bilateral
- Absence semicircular canals.
- Hypoplastic vestibules
- Hypoplastic Cochlear nerve fossette and IAC



9) Large Vestibular Aqueduct Syndrome (LVAS)

Vestibular aqueduct

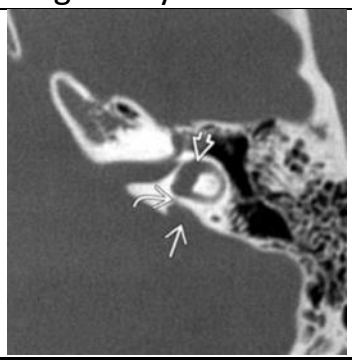
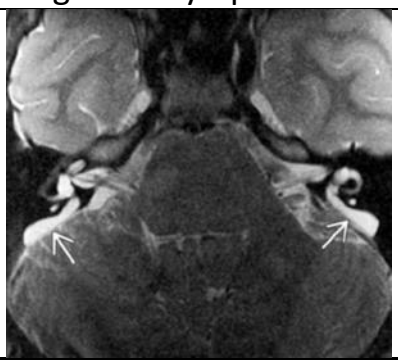
Normal: Equal to or smaller than lateral semicircular canal

Abnormally: > 1.5 mm, mid-bony vestibular aqueduct.

Pendred Syndrome :

Large Vestibular Aqueduct Syndrome

Goitrous Thyroid Glands With Or Without Hypothyroidism

Large bony vestibular aqueduct	Large endolymphatic duct & sac
	

10) IAC & Cochlear Nerve Anomalies

IAC Normal diameter = 2-8mm (Avergae = 4mm)

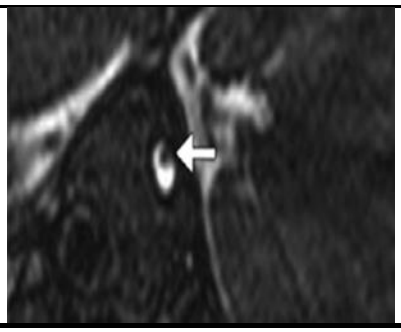
Stenotic IAC < 2mm

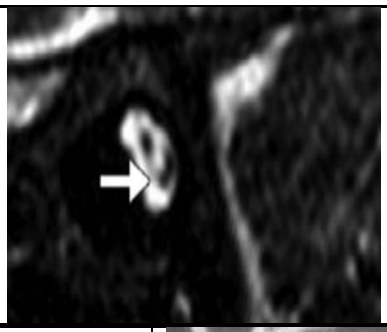
Sagittal oblique view ⊥ long axis of IAC => 4 major nerves:

Fascial – Cochlear – Superipr vestibular – Inferior vestibular

3 types of choclear nerve anomalies

Type 1: Stenotic IAC Absent 8th nerve (Cochlear + Vestibular)	Type 2: Common vestibulocochlear n. is present Hypoplasia or aplasia of its cochlear branch Type 2A: Associated with other inner ear anomalies Type 2B: No associations



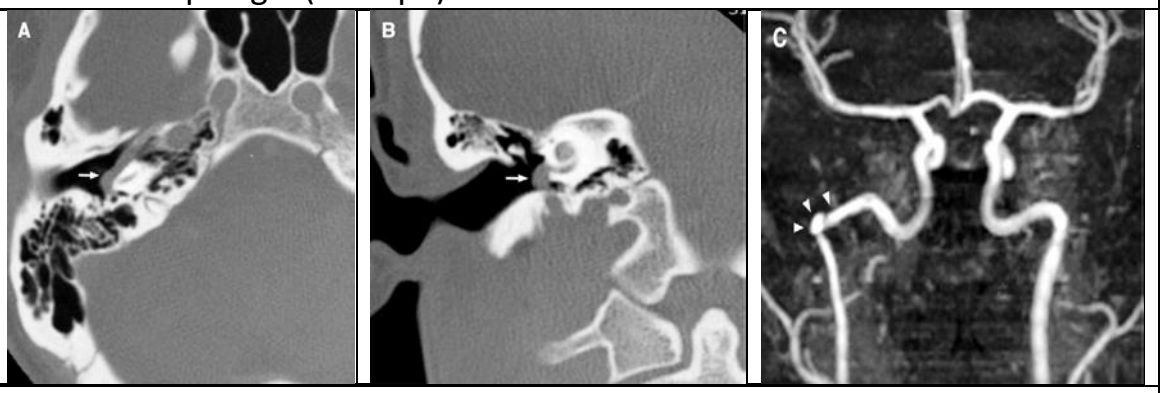


11) Bilateral Persistent Stapedial Artery (PSA)

coursing over the cochlear promontory.

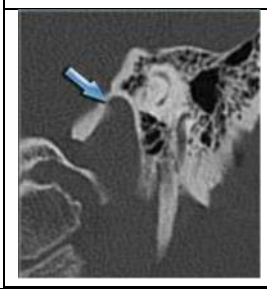
12) Aberrant ICA

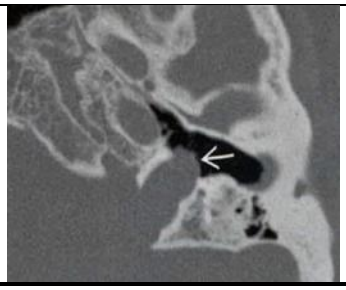
Aberrant ICA course through middle ear over cochlear promontory
MRA => sharp angle (7-shape)

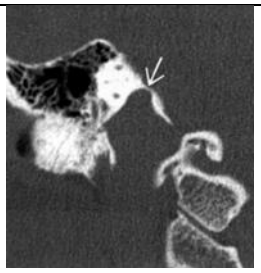


13) Venous Anomalies

High Jugular Bulb	Dehiscent Jugular Bulb	Jugular Bulb Diverticulum

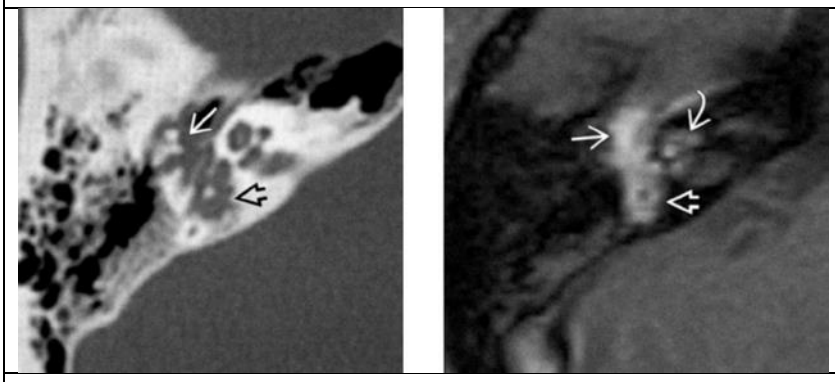






❖ Acute LABYRINTHITIS

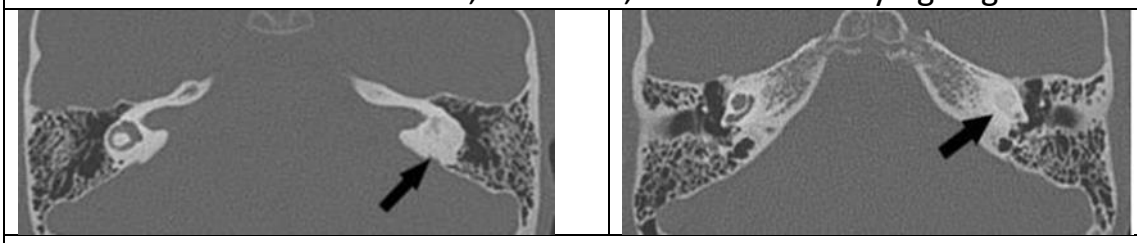
Inflammation of the membranous labyrinth.
Viral infection: is the most common cause.
T1 C+ FS: moderate enhancement within normally fluid-filled spaces of inner ear.
T2 high-resolution differentiates labyrinthitis from intralabyrinthine schwannoma



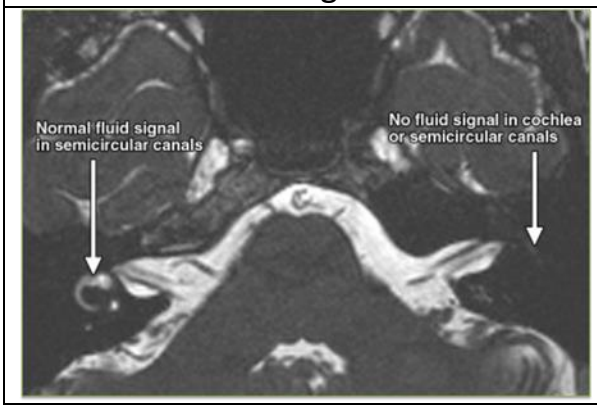
❖ Labyrinthine Ossificans = Chronic Labrinthitis

Secondary to meningitis or trauma.

CT: ossification of the cochlea, vestibule, and SCCs in varying degrees



MRI: Absent Fluid Signal of Cochlea or SCC

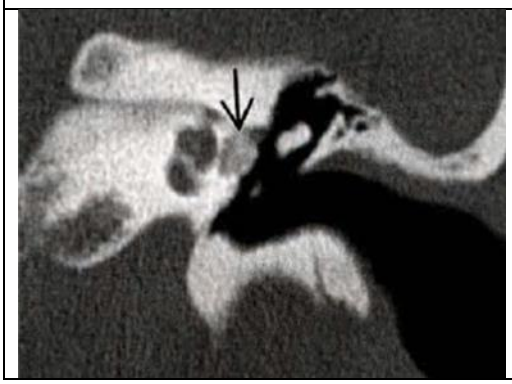
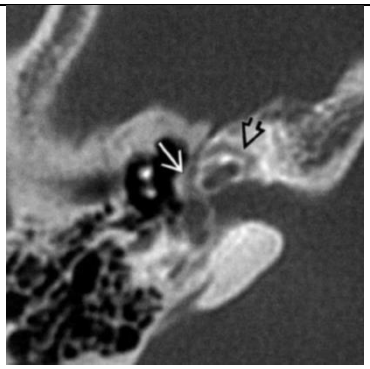


❖ Otosclerosis = Otospongiosis

Metabolic bone disease of unknown etiology.
Bilateral 90%, F>M

<u>3 pathologic phases :</u>

1) Acute phase: Deposition of islets of osteoid tissue
2) Subacute phase= otospongiotic phase: Spongiotic remodeling with osteoclasts causing focal bone resorption
3) Chronic-sclerotic phase= otosclerotic phase : Osteoblasts create new bone with irregular features that resemble a mosaic

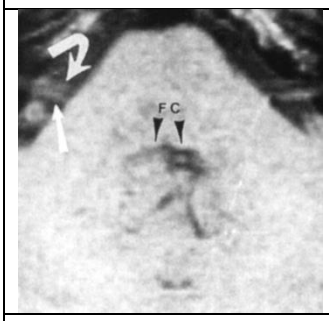
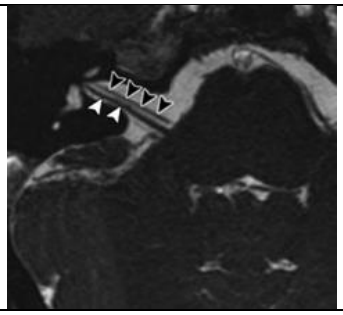
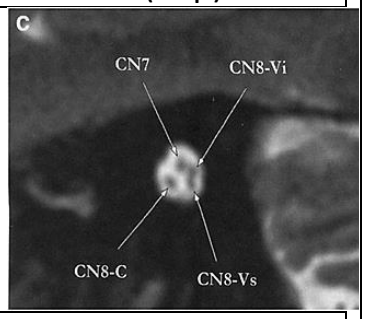
FENESTRAL OTOSCLEROSIS	**COCHLEAR OTOSCLEROSIS**
Common	Less common
Conductive hearing loss (CHL)	Sensory neural hearing loss (SNHL)
Lucent halo/spongiosis/sclerosis around oval window	Lucent halo/spongiosis/sclerosis around cochlea
	

Petrous Bone

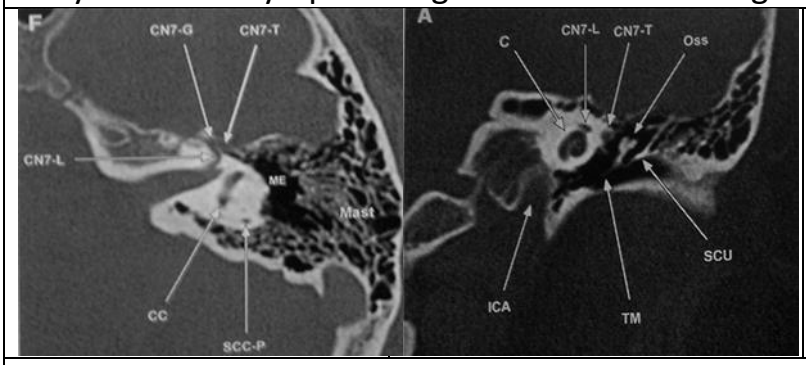
IV. Facial Nerve

Anatomy:

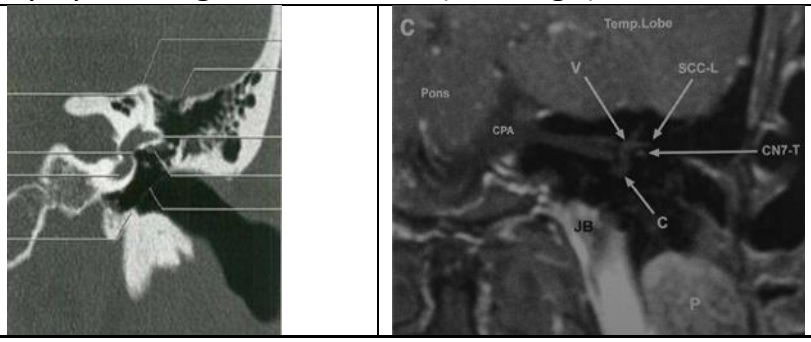
CN7 segments:
Intra-axial (Pontine), CPA/lAC, labyrinthine, tympanic, mastoid, parotid

Pontine segment => Facial coliculi	CPA segment => Anterior to 8CN	lAC => Superior & Anterior (7up)
		

Labyrinthine + Tympanic segments + Geniculate ganglion



Tympanic segment: Coronal (Tree sign) => Below LSSC



DD: Facial nerve enhancement:

1) Bell's palsy
2) Ramsey-Hunt syndrome
3) Schwannoma
4) Perineural spread of tumor.

Normal FN enhancement = Linear enhancement + Tympanic segment

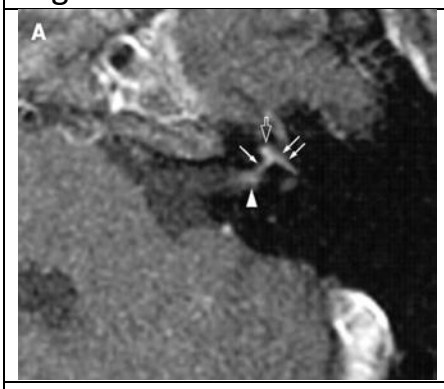
1) Bell's Palsy

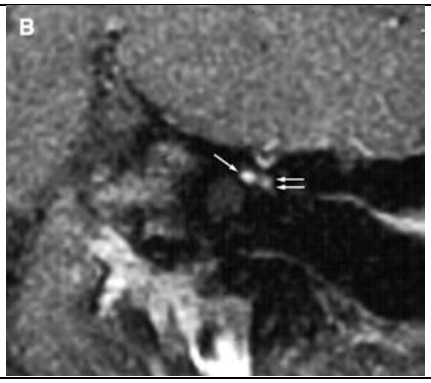
Acute onset of unilateral peripheral facial nerve palsy.

Resolve in 6w – 3m.

Radiological features:

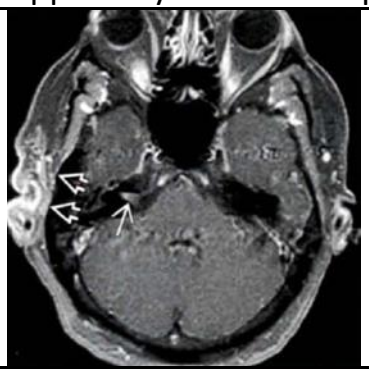
T1+C FS: linear enhancement of the intra-canalicular and labyrinthine segments of the facial nerve.

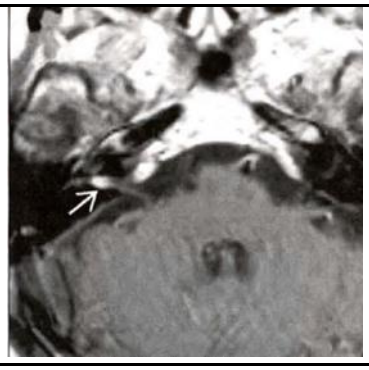




2) RAMSAY HUNT SYNDROME

Varicella zoster virus infection involving sensory fibers of 7/ 8 cranial nerves & portion of external ear supplied by auriculotemporal nerve.



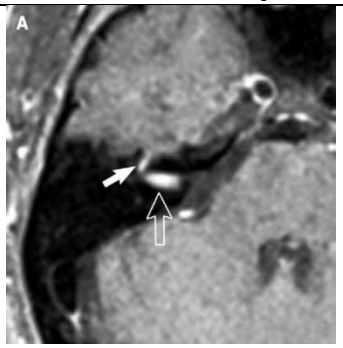


3) FACIAL NERVE SCHWANNOMA

Benign tumor arising from the schwann cells of the nerve sheath.
Age: Middle age group
Sex: F > M

Radiological features:

CT: ↑Size labyrinthine Facial nerve canal ± geniculate fossa
T1: low signal
High-resolution T2 MR: "Filling defect" within hyperintense perilymph

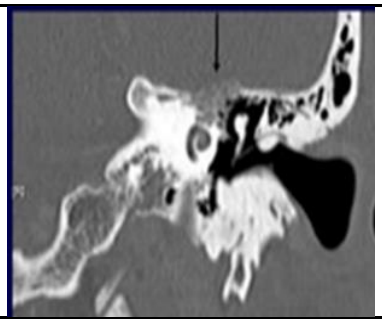
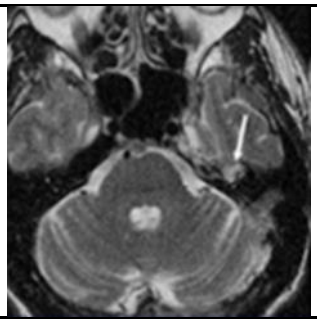
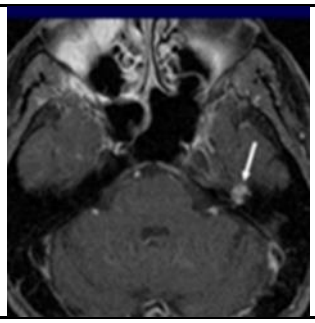
T1+C FS: Enhancing CPA-lAC mass + "tail" in labyrinthine FN	T1+C FS: Enhancing mass intra-canalicular + labyrinthine FN
	

4) Facial Nerve Hemangioma

Rare vascular tumor

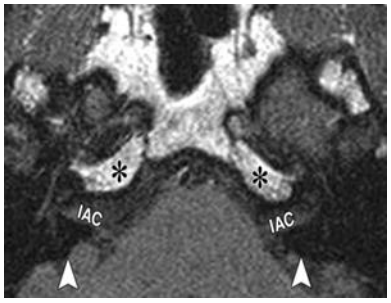
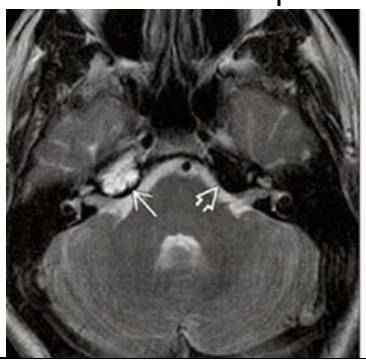
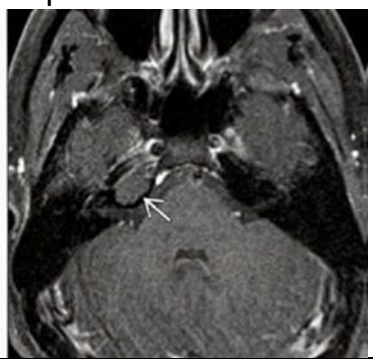
Radiological features:

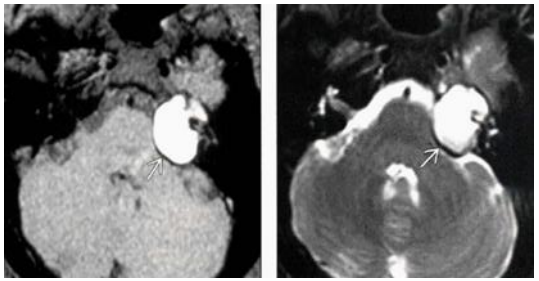
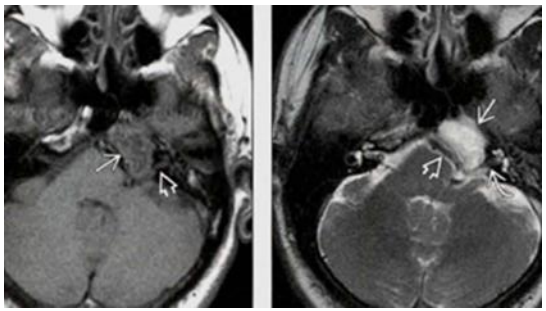
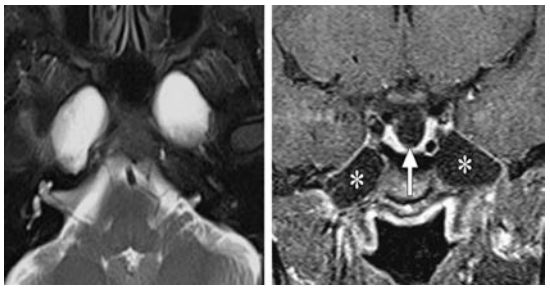
CT: honecomb pattrern of bone erosion
T1: Low signal
T2: high signal
T1 +C FS: Avid enhncement

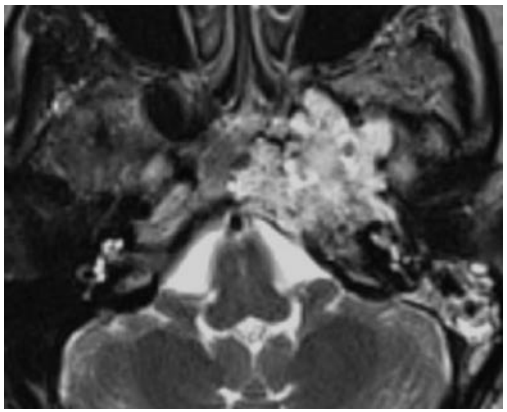
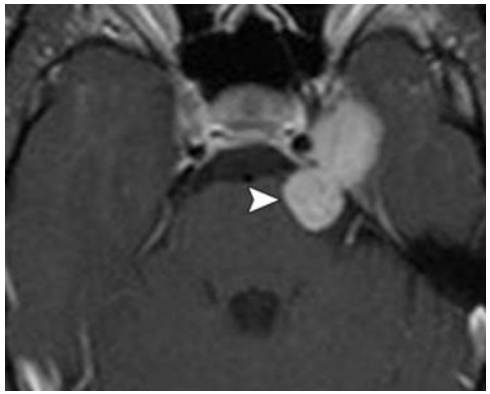




Petrous Bone

V. Petrous Apex

Normal Petrous Apex	Pneumatized Petrous apex	Petrous Apex Effusion
Fatty marrow	Air	Opacified air cells with fluid
CT: No cortical destruction or erosion or expansion +C: No enhancement		
T1: High signal T2: High signal T1 FS: Loss of signal	T1: Low signal T2: Low signal	T1: Low signal T2: High signal
	RT= Petrous apex effusion LT= Pneumatized petrous apex 	

Cholesterol Granuloma	Congenital Cholesteatoma	Meningocele
Most common lesions in petrous apex.	EPIDERMOID	Rare lesion. Usually bilateral.
due to recurrent hemorrhage and foreign body reaction within aerated petrous apex.		Protrusions of arachnoid or dura mater, usually from the Meckel cave, into the petrous apex
Expansile petrous apex lesion **CT: Smooth-lobular bone remodeling** **NO enhancement.**		
T1: High signal T2: : High / Low signal Low signal hemosiderin rim Fat-saturated: high signal	T1: low signal T2: high signal DWI: RESTRICTED =High signal	T1: low (CSF-signal) T2: High (CSF-signal) DWI: Facilitated (CSF-signal) +/- Empty sella
		

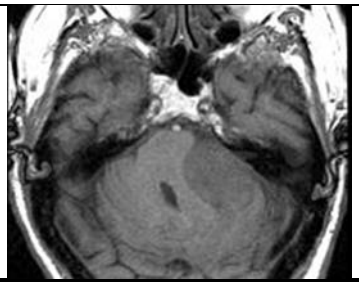
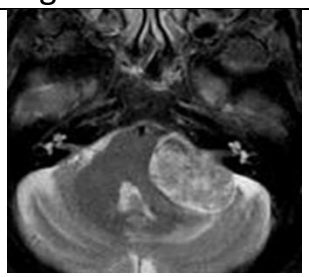
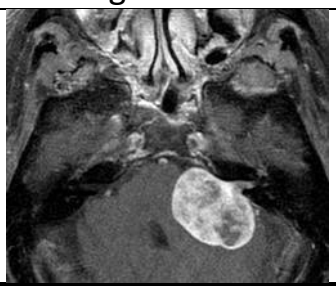
Chondrosarcoma	Petroclival Meningioma	Trigeminal Schwannoma
Malignant bony lesion	Benign lesion of the meninges	Benign neurogenic tumor
	Age: middle age Sex: F > M	Age: Middle age group Sex: F > M
Location Petro-occipital fissure (2/3) Anterior basisphenoid (1/3)		CPA => Petrous apex => Meckel's cave
Ill defined lesion CT: Petrous apex destruction Chondroid Ca: Rings & arcs T1: Low signal T2: high signal + low signal foci +C: Mod heterogeneous enh	Well defined dural based lesion CT: Bone sclerosis T1: Iso – low T2: Iso – low +C: Marked homogenous enh Dural tail enhancement	Well defined lesion Dumbbell shaped lesion T1: Low signal T2: High signal ± Cystic changes +C: Mod heterogeneous enh + Non-enhancing cystic comp.
		

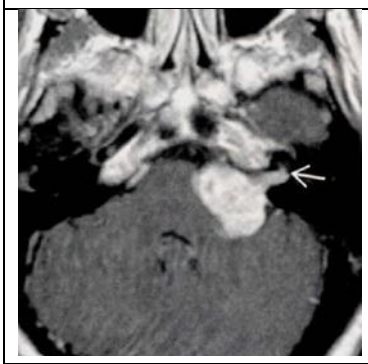
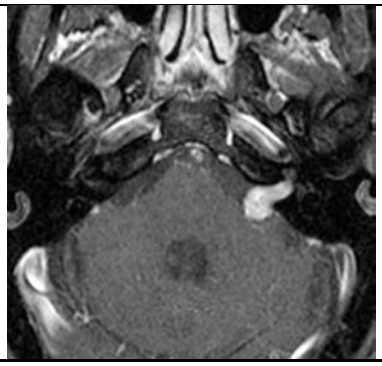
VI. CPA – IAC Lesions

Vestibular Schwannoma	Meningioma
1st most common CPA tumor 80 – 90 %	2nd most common CPA tumor 10 – 15 %
Benign tumor arising from the Schwann cells of the nerve sheath.	Benign tumor of the meninges.
NF-II = Schwannoma + Meningioma + Ependymoma	
Age: Middle age group Sex: F > M	
Spherical shape Long axis of the lesion is parallel to IAC axis	Hemispherical = Mushroom cap Long axis of lesion is parallel to the petrous
Intra-canalicular extension: common => Ice cream cone shape	Intra-canalicular extension: rare
CT: Hypodense T1: Low signal T2: High signal +/- Cystic changes +C: Moderate heterogeneous enhancement + Non-enhancing cystic component	CT: Hyperdense T1: Iso -Low signal T2: Iso - High signal +C: Moderate Homogenous enhancement + Meningeal tail

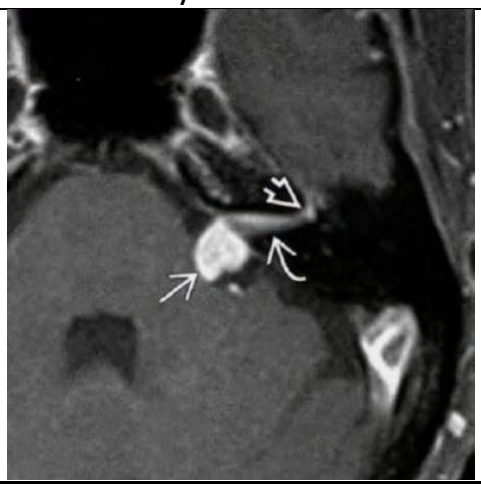
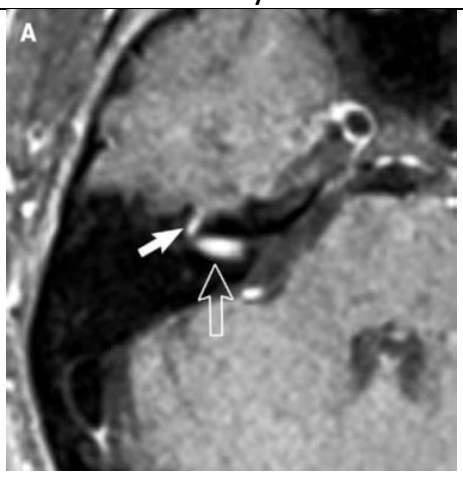
Vestibular Schwannoma

Most common type of CPA schwannoma

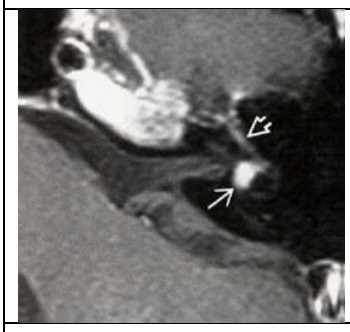
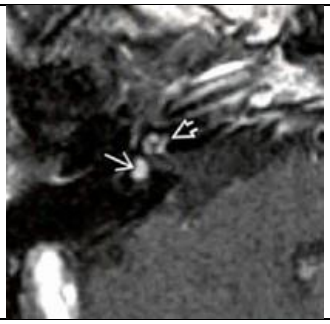
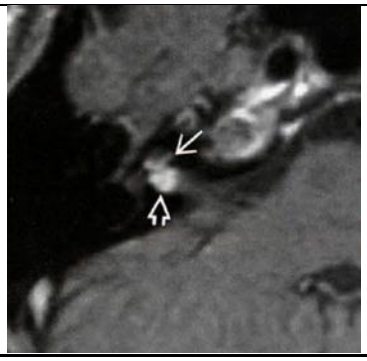
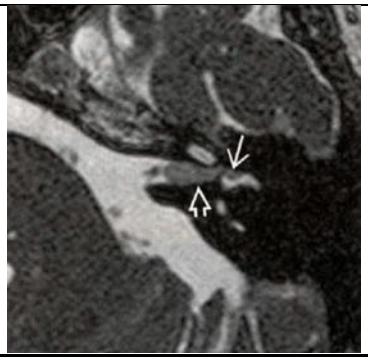
T1: Low	T2: heterogeneous High	T1+C: Moderate heterogeneous enh.
		

CPA mass + Intra-canalicular extension	CPA-IAC mass	Intra-canalicular mass
		

Facial nerve Schwannoma

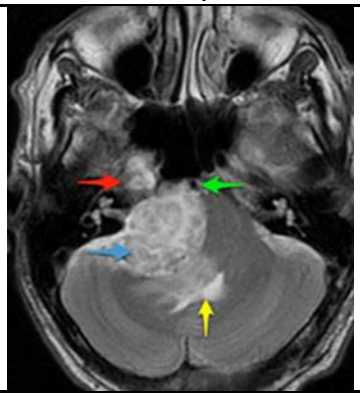
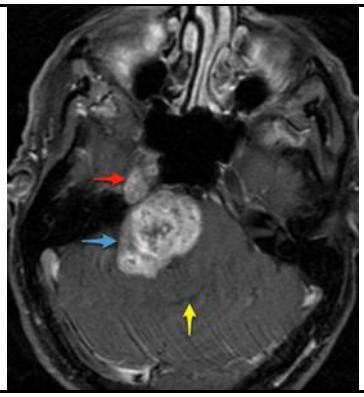
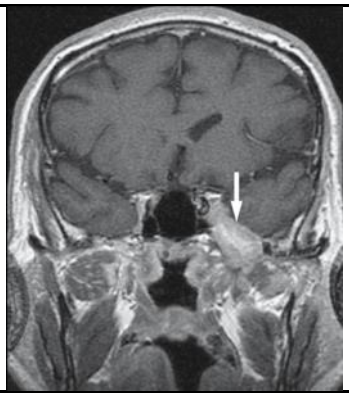
T1+C FS: Enhancing CPA-lAC mass + "tail" in labyrinthine FN	T1+C FS: Enhancing mass intra-canalicular + labyrinthine FN
	

Intralabyrinthine Schwannoma

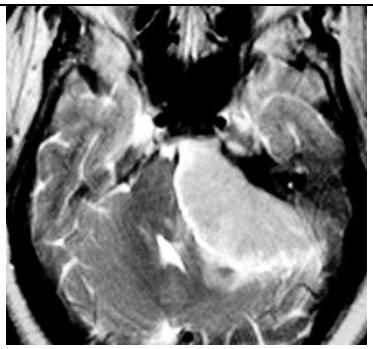
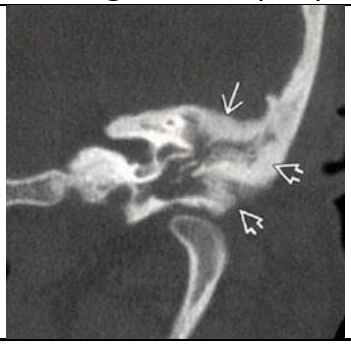
Intra-vestibular Schwannoma	Intra-chochlear Schwannoma	Vestibulocochlear Schwannoma
		
Transmodiolar = Cochlea => fundus of lAC	Transmacular = Vestibule => fundus of lAC	Transotic = fundus of lAC => entire inner ear => middle ear
		

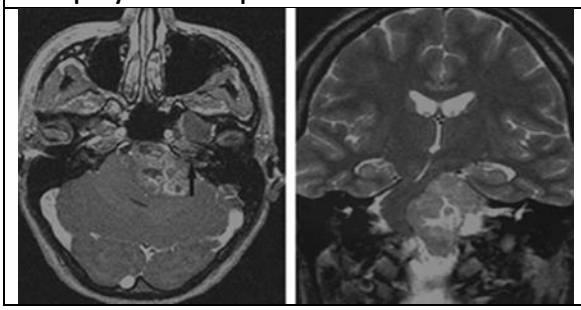
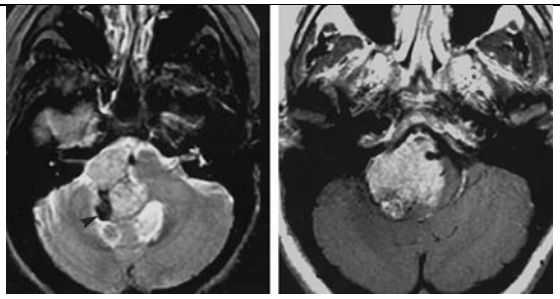
Trigeminal Schwannoma

Dumbbell shaped mass = CPA + Meckel's cave components

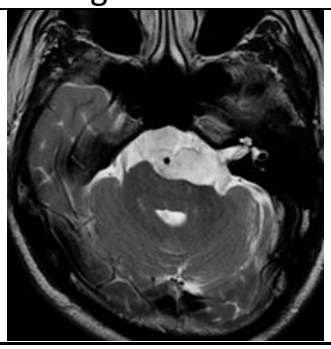
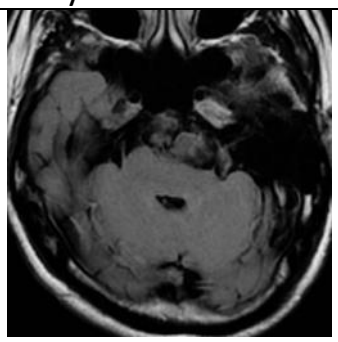
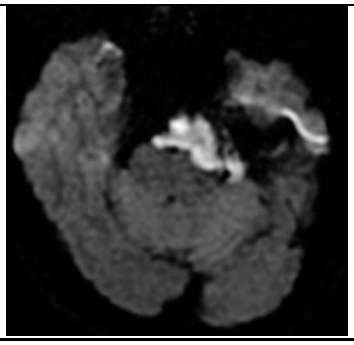
Meningioma

T1: Iso – Low signal	T2: Iso – High signal	T1+C: Marked Homogenous enh.
		
Dural tail	Meningioma en-plaque	
		

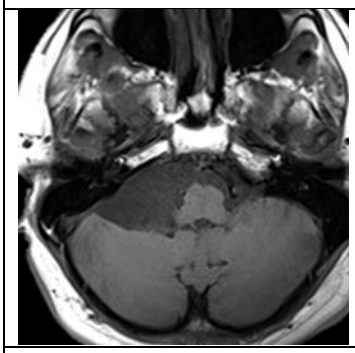
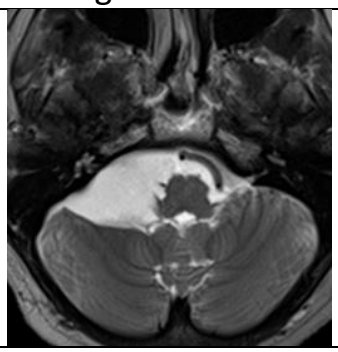
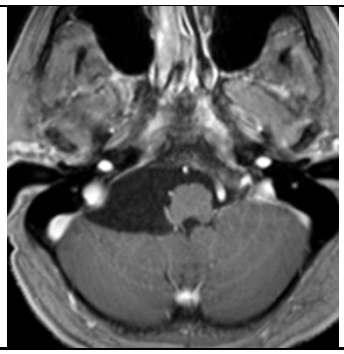
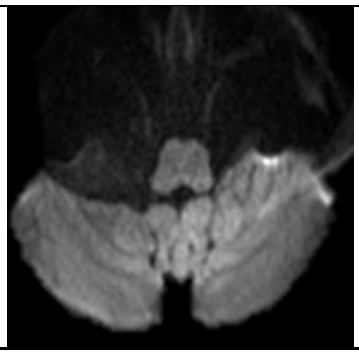
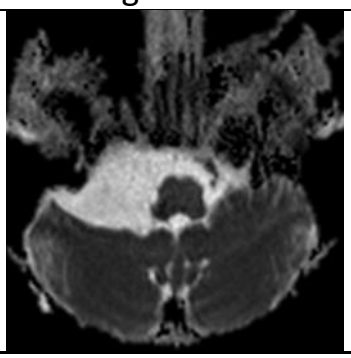
Pediatric Posterior Fossa Tumors	**Adult Posterior Fossa Tumors**
Ependymoma	**Choroid Plexus Papilloma**
Arise in the 4th ventricle and its lateral recesses => **F. Luschka** Exophytic component => CPA	
	

Epidermoid	Arachnoid cyst	Lipoma
3rd most common CPA tumor 5 – 9 %	Rare CPA tumor < 1 %	Rare CPA tumor < 1 %
Insinuating mass Engulfs cranial nerves (7th & 8th), vessels (AICA, vertebral artery)	Mass effect om the pons, middle cerebellar peduncles and cerebellar hemisphere.	
NECT: CSF density T1: Low = CSF signal T2: High = CSF signal		NECT: Fat density T1: High signal T2: High signal
+C: NO ENHACEMENT		
FLAIR: "incomplete attenuation“ DWI: Restricted = High signal	FLAIR: Complete fluid attenuation DWI: No restriction =low signal	STIR: Signal disappear T1 FS +C: Signal disappear

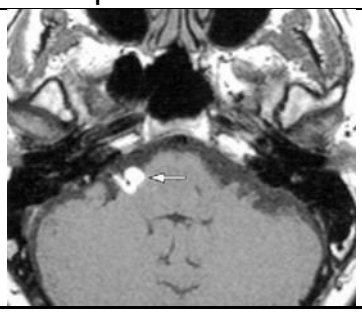
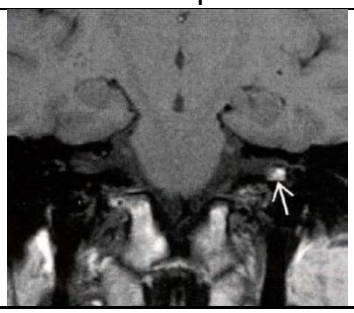
Epidermoid

T2: high CSF like	Dirty FLAIR	Restricted DWI
		

Arachnoid Cyst

T1: Low = CSF	T2: High = CSF	FLAIR: Low = FLAIR
		
+C: No enhancement	**DWI= No restriction**	**ADC: High = CSF**
		

Lipoma

CPA lipoma	IAC fundal Lipoma	CPA+Vestibular lipoma
		

Vascular Loop Compression

Vascular loop compressing cranial nerves within CPA-lAC cistern

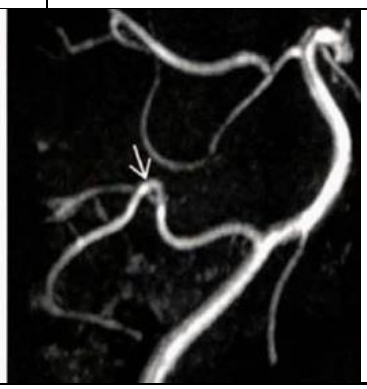
A) **<u>Trigeminal n. vascular loop syndrome</u>** = Vascular loop in high CPA cistern compress 5th CN at root entry zone(REnZ)=> trigeminal neuralgia

B) **<u>Facial n. vascular loop syndrome</u>** = Vascular loop in mid-CPA cistern compresses 7th CN at root exit zone (RExZ) => hemifacial spasm.

Tortuous Vertebral artery

PICA loop

AICA loop

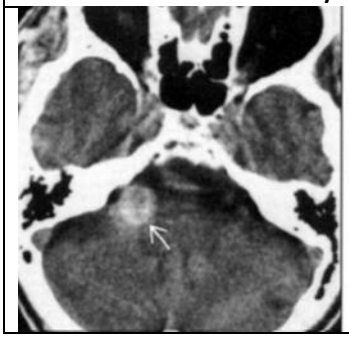


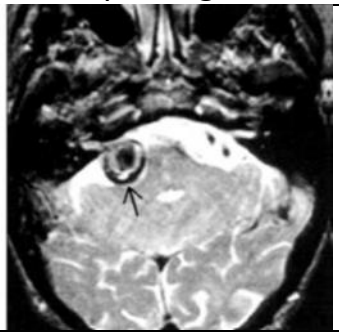
CPA Aneurysm

CPA aneurysms from PICA> VA> AICA

CT: CPA lesion with calcified rim

T2: "flow void“ or layered complex signal in wall

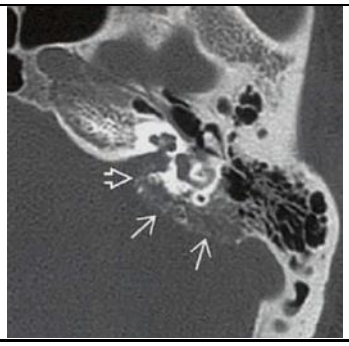


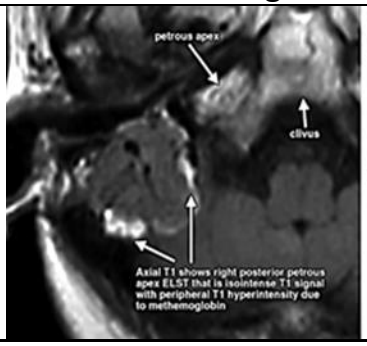


Endolymphatic Sac Tumor

Centered in fovea of endolymphatic sac in pre sigmoid, posterior surface of petrous Temporal bone
Aggressive soft tissue mass that erodes posterior wall of temporal bone and posterolateral jugular foramen wall.
Spread to involve middle ear, CPA cistern & jugular foramen.
CT: Bone erosion of posterior wall of petrous bone + vestibular aqueduct + Jugular foramen
T1+C: Heterogeneous enhancement

CT: Bone erosion	T1: Hyperintense foci due to hemorrhage	T2: signal voids due to high vascularity

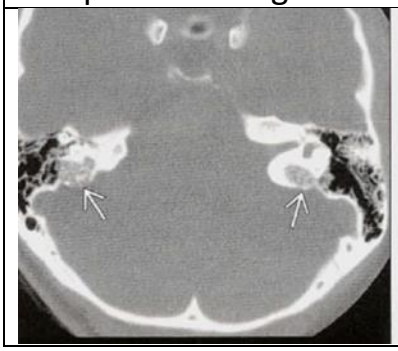



petrous apex
clivus
Axial T1 shows right posterior petrous apex ELST that is isointense T1 signal with peripheral T1 hyperintensity due to methemoglobin

axial T2 shows heterogeneous T2 signal within the mass and multiple small vascular flow voids indicating a hypervascular ELST

VHL

- Bilateral endolymphatic sac tumors
- Pheochromocytoma (arrow)
- Pancreatic cysts (open arrows)
- Spinal hemangioblastoma (curved arrow).



Petrous Bone

VII. Jugular Foramen

❖ Anatomy:

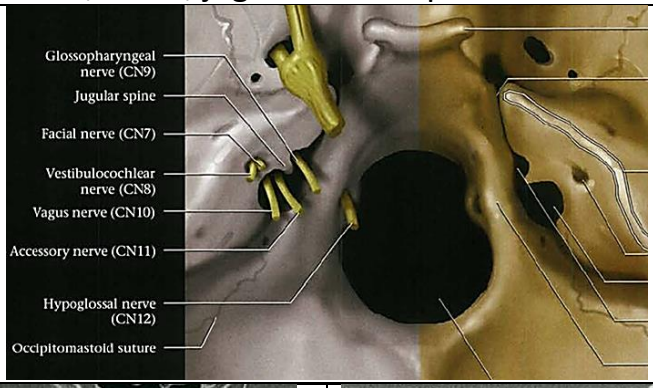
Two parts: Pars nervosa & pars vascularis partially
Divided by jugular spine
Between temporal & occipital bones

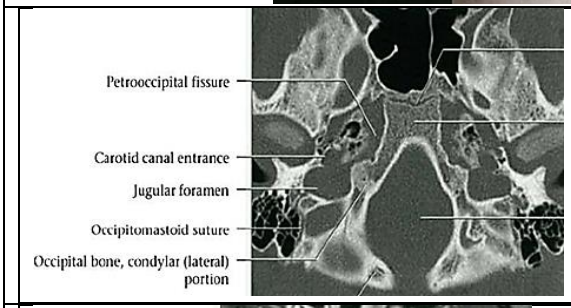
A. Pars nervosa

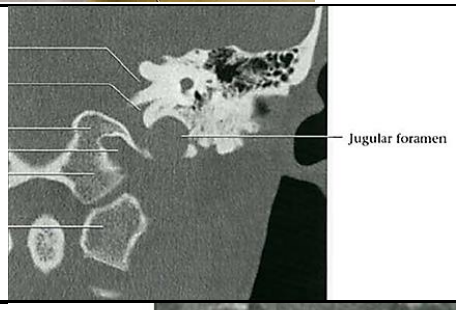
Anteromedial
Transmits CN9, Jacobson nerve & inferior petrosal Sinus

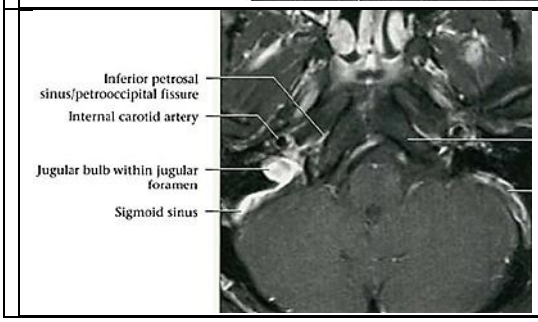
B. Pars vascularis

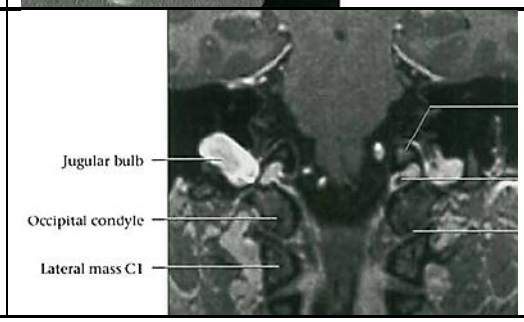
Posterolateral
Transmits CN10, CN11, jugular bulb & posterior meningeal artery

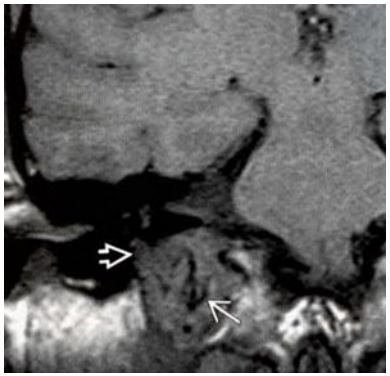
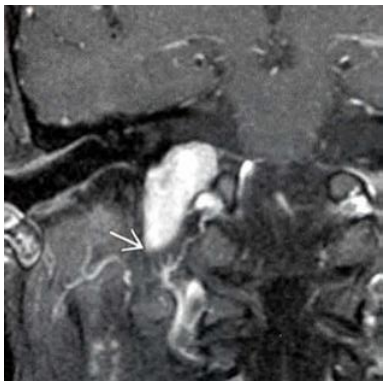
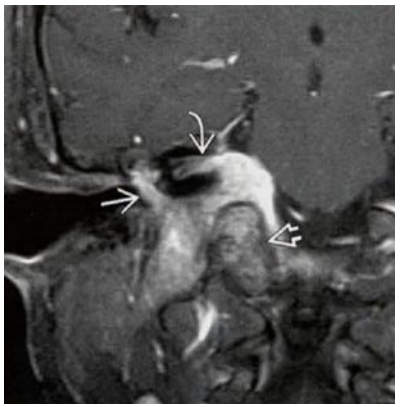






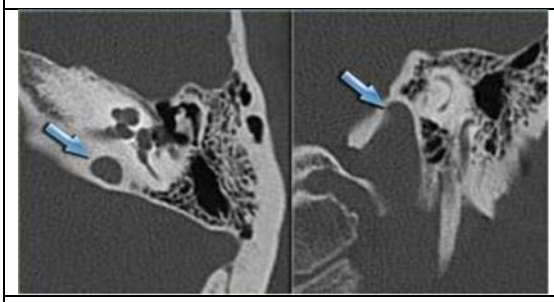




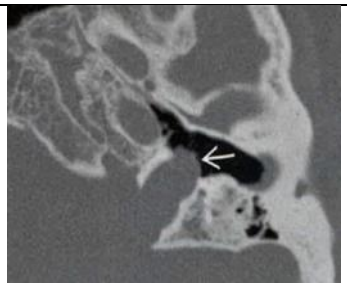
Glomus jugulare	Schwannoma	Meningioma
1st common	2nd common	3rd common
Benign tumor arising from neural crest cells	Benign neurogenic tumor	Benign tumor of meninges
Age = Middle – Adult F>M		
CT: Permeative destructive	CT: Smooth widening	CT: Permeative sclerotic
T1:Low + Salt & pepper T2: High + Pepper	T1: Low signal + NO pepper T2: High signal ± Cystic changes	T1: Iso – Low signal T2: Iso – High signal
+C: Marked heterog. enh.	+C: Moderate enhancement + Non-enhancing cystic comp	+C: marked homogenous enh. + Dural tail enhancement
		

❖ Venous Anomalies

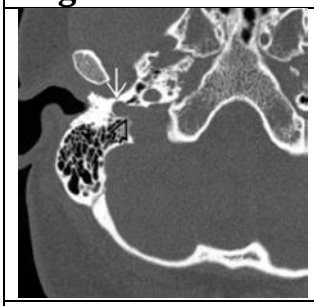
High Jugular Bulb

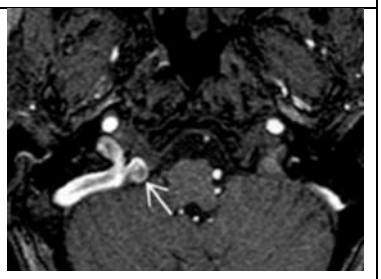


Dehiscent Jugular Bulb

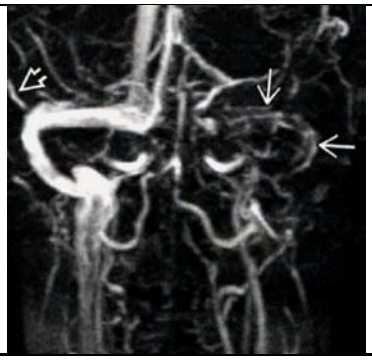


Jugular Bulb Diverticulum

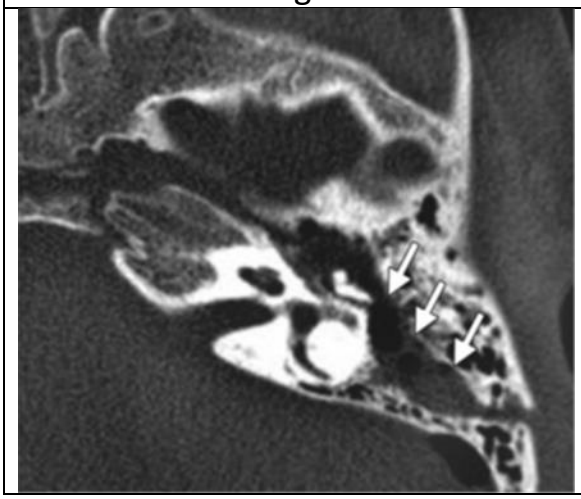
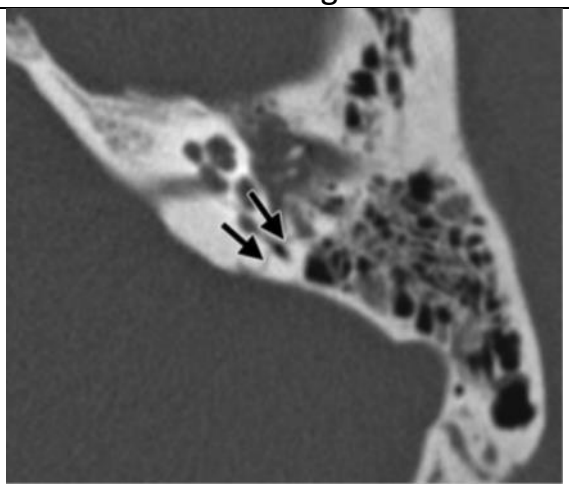




IJV Thrombosis



Petrous Bone Trauma

Longitudinal Fracture	Transverse Fracture
Common. 70 – 90 %	Less common. 10 – 30 %
Fracture // Longitudinal axis of petrous bone	Fracture ⊥ Longitudinal axis of petrous bone
Middle ear	Inner ear
Ossicular injury Tympanic membrane rupture Hemotympanum	Semicircular canal injury Facial n paralysis Opacification of mastoid air cells.
Conductive hearing loss	Sensorineural hearing loss
	

Petrous Bone

SNHL

I. Cochlear causes:

a. Congenital => Look for inner ear congenital anomalies
b. Trauma => Look for Petrous fractures
c. Infection => Look for inner ear
    i. Acute Labyrinthitis
    ii. Labyrinthine Ossificans
    iii. Otosclerosis = Otospongiosis
d. Neoplastic

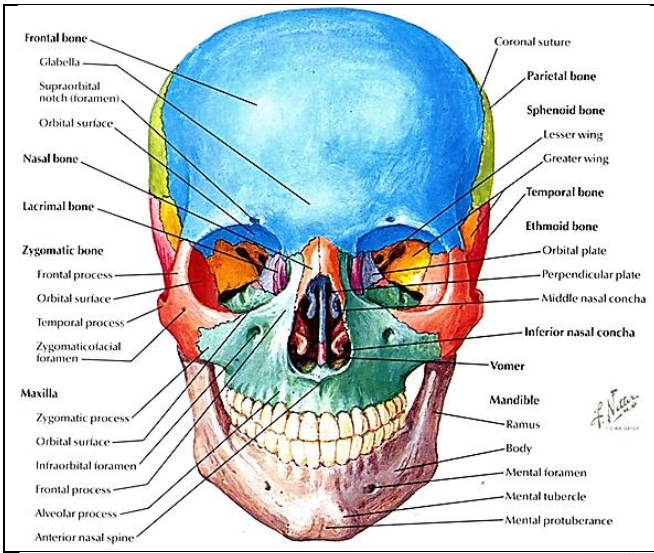
II. Retro-cochlear causes:

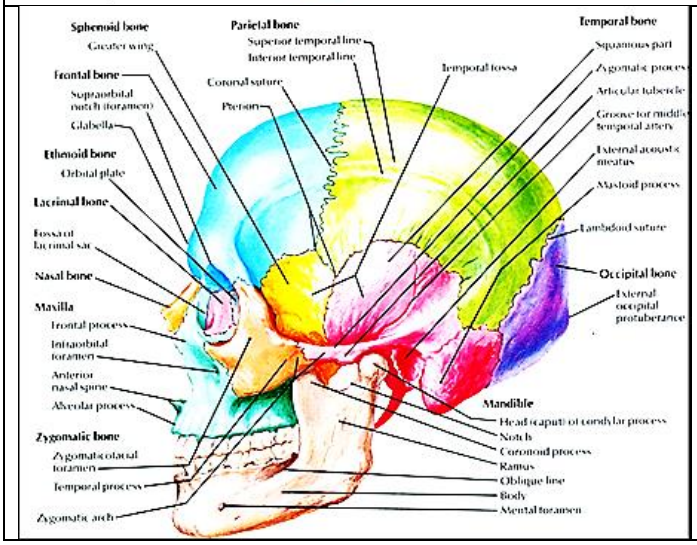
a. CPA/IAC:
    i. Neoplastic lesions => Look for CPA/IAC tumors
    ii. Vascular loop => Look for CPA/IAC
    iii. Meningitis

b. Intra-axial => Brain stem:
    i. Neoplastic
    ii. Ischemic
    iii. Traumatic
    iv. Demyelinating

Facial Fractures

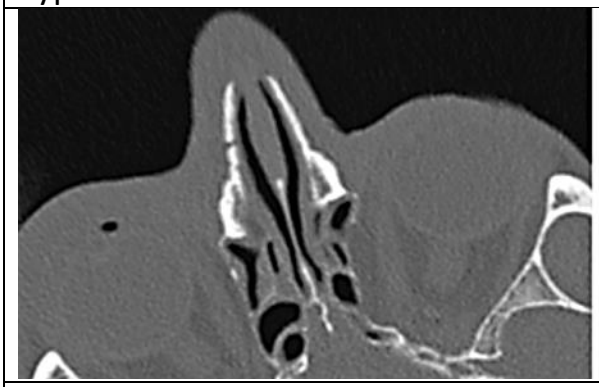
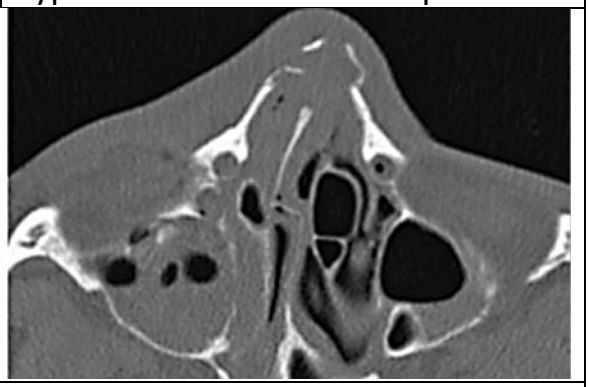
Simple #	Complex #	Transfacial #
Nasal bone Orbital wall Frontal bone Sinus Zygomatic arch Mandible	Naso-frontal Naso-ethmoidal Naso-maxillary Zygomatico-maxillary	Le Fort I, II, III Smash injury Multiple fractures



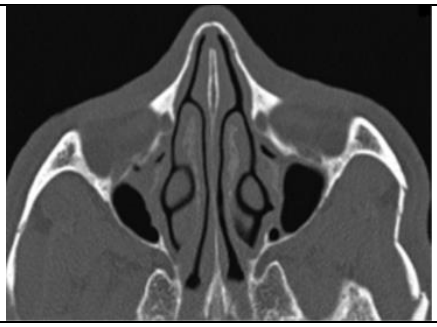


❖ Simple Facial

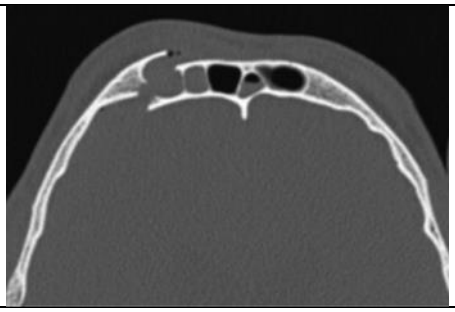
1) Nasal

Commonest (50% of facial injuries)	50% complex # ⇨ Naso-ethmoidal # ⇨ Naso-frontal # ⇨ Naso-maxillary #
<u>3 types:</u> Type 1 limited to nasal bone Type 2 Nasal bone + nasal septum Type 3 Nasal bone + Nasal septum + orbital bone ± intracranial structures	**<u>Complications:</u>** Septal hematoma Septal Abscess Septal perforation Cartilage necrosis
Type 1: Rt nasal bone #	Type 2: Bi nasal bones + Septal #
	

2) Zygomatic arch

Segmental + Comminuted # Depressed bone fragment ⇨ Impingement of temporalis muscle ⇨ Impingement of mandibular coronoid process => Trismus	

3) Frontal sinus

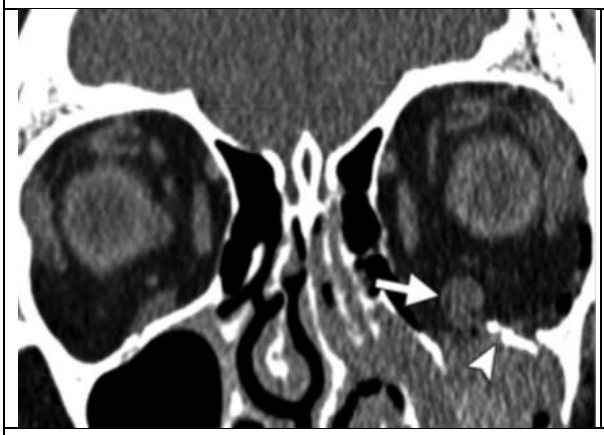
Anterior wall ± Posterior wall # Opacification of frontal sinus = Hemosinus Intracranial complications: ⇨ Small foci of pneumocephalus. ⇨ Intracranial infections ⇨ CSF rhinorrhea	

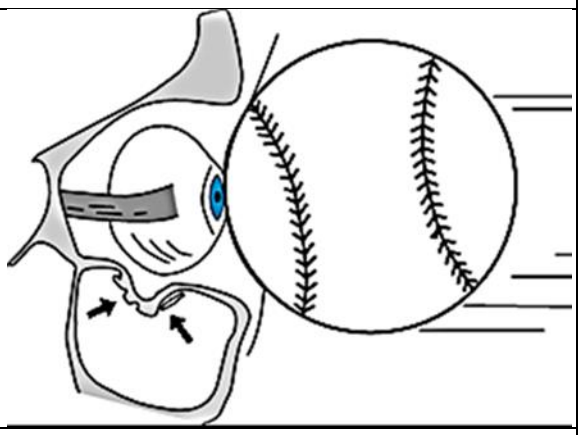
4) Orbital Blowout

Blunt trauma to the orbit by a large object that can't enter the orbit.

Trapdoor # = Inferior Orbital Wall Blowout

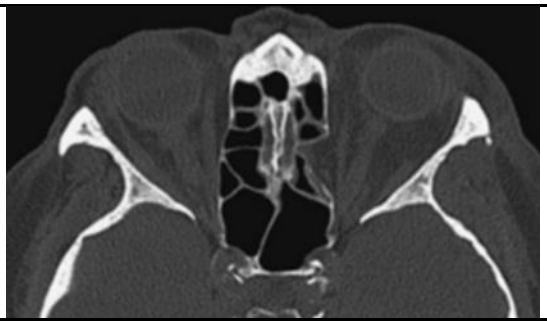
- ⇨ 1st common type
- ⇨ Intra-orbital fat herniates into the maxillary sinus
- ⇨ Inferior rectus muscle herniates into the underlying maxillary sinus => Entrapping the muscle => Diplopia
- ⇨ Orbital emphysema
- ⇨ Enophthalmous
- ⇨ Hemosinus





Medial Orbital Wall Blowout

- ⇨ **Lamina papyracea #**
- ⇨ 2nd most common type
- ⇨ Orbital emphysema
- ⇨ Hemosinus
- ⇨ No muscle dysfunction



Orbital Roof

Most rare type

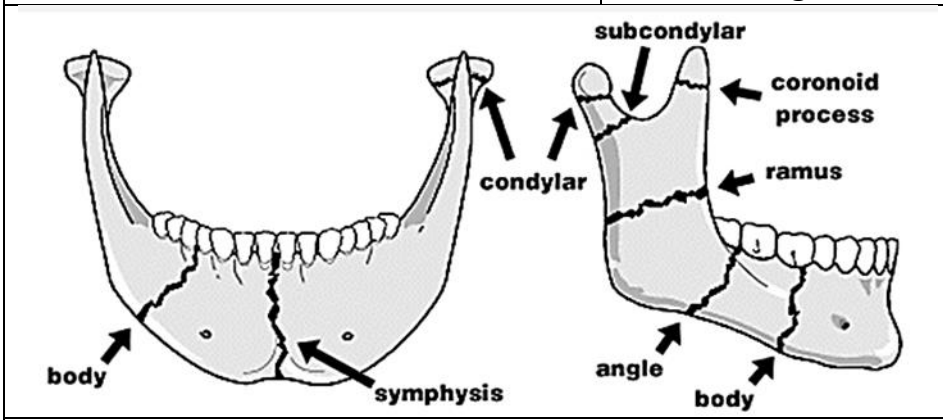
Globe Rupture

- ⇨ Flat tyre appearance of the globe
- ⇨ Thickening of the sclera
- ⇨ Hazy inner sclera
- ⇨ Inta-occular air
- ⇨ Vitreous hemorrhage
- ⇨ Lens dislocation

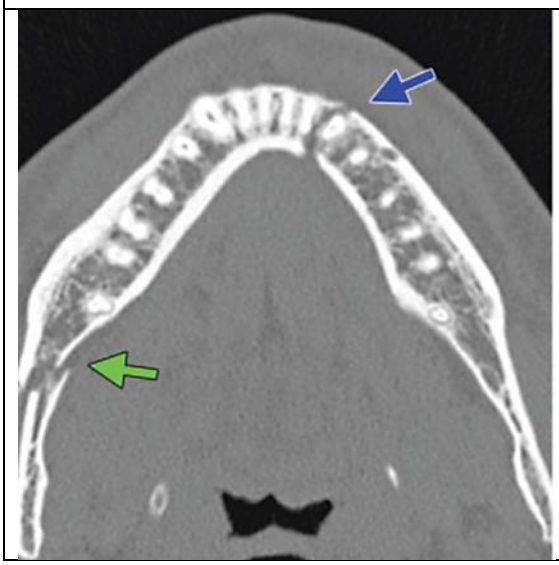
5) Mandibular

U-shaped = Ring-shaped mandible
- ⇨ 2 fractures
- ⇨ Fracture - dislocation

Angle: 20-33% 1-3
Body: 15-25%
Condyle or neck: 15-36%
Parasymphyseal: 14-15%
Ramus: 5%
Coronoid process: 1-3%
Alveolar ridge: 2%



Left parasymphyseal # (blue arrow)
Right mandibular body # (green arrow)
Distraction of mandibular canal



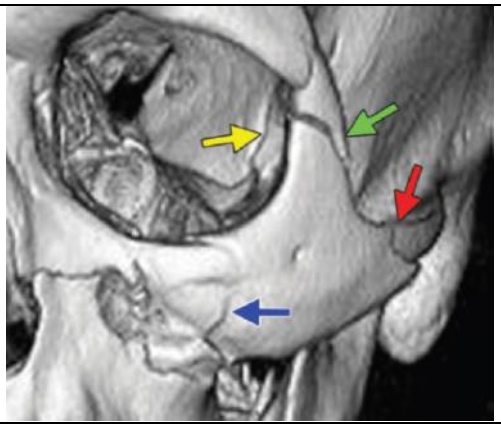
❖ Complex Facial

1) Zygomaticomaxillary = Tetrapod Complex

2nd most common #

Disruption of:

1) Zygomatico-frontal suture = lateral orbital wall
2) Zygomatico-maxillary suture = Anterior wall of maxilla
3) Zygomatico-temporal suture = Zygomatic arch
4) Zygomatico-sphenoid suture = Orbital apex

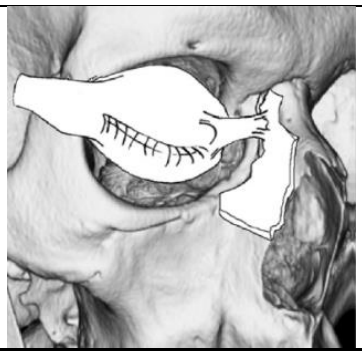
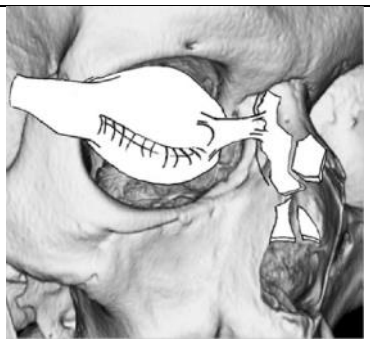
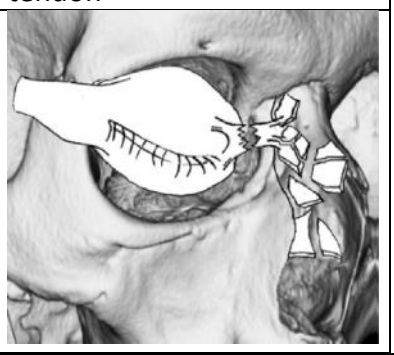


Posterior displacement of zygoma
Medial and lateral rotation of zygoma
Infra-orbital foramen => Infra-orbital nerve injury
Orbital volume:
Enlarged => Enophtlalmos
Reduced => Exophthalmos

2) Naso-Orbito-Ethmoid (NOE) Complex

Caused by a high-impact force applied anteriorly to the nose and transmitted posteriorly through the ethmoid bone.

Markowitz and Manson classification :

Type I: medial canthal tendon is intact	Type II: comminuted # + not extend to medial canthal tendon => attached to single bone fragment	Type III: comminuted # + extends to medial canthal tendon => avulsion of the tendon
		

The tendon itself is not visible at multidetector CT.
The radiologist's report the degree of comminution of the medial orbital wall at the level of the lacrimal fossa => helpful for surgical planning of medial canthal tendon repair.

❖ Transfacial # = Le Fort

Type I Le Fort fracture = Floating Palate

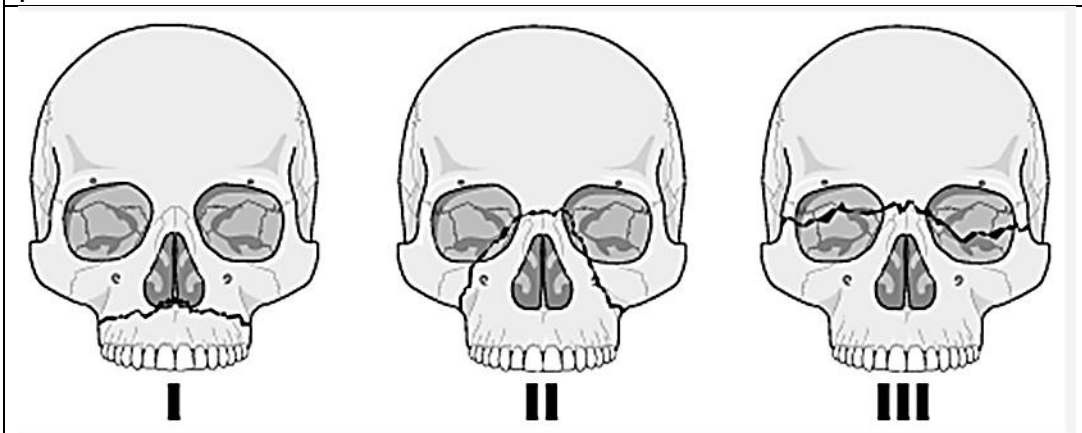
Separates hard palate and alveolar margin from face
Horizontal #
Anterior, lateral, and medial maxillary walls
Inferior margin of the piriform aperture and nasal septum
Extending posteriorly through the pterygoid plates

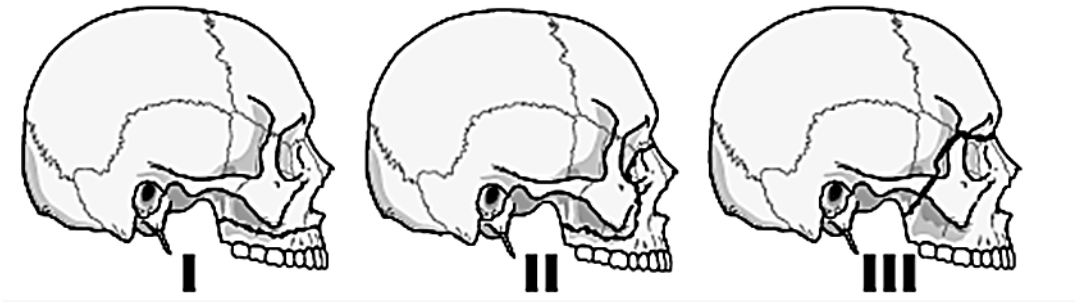
Type II Le Fort fracture = Dish-face deformity

Pyramidal fracture
The apex of the pyramid is situated at or just inferior to nasofrontal suture.
=> Lacrimal bones => Medial orbital wall => medial orbital floor => anterior maxillary wall => lateral maxillary wall => Pterygoid plates.
Intact lateral orbital wall + Zygomatic arch.
Posterior displacement => Dish-face deformity

Type III Le Fort fracture = Craniofacial dissociation

This fracture begins at the nasofrontal suture
=> Medial orbital wall => Lateral orbital wall => Zygomatic arch => Pterygoid plates





Skull Base Lesions

DD by Layers:

A. Meninges:

a. Meningioma / Hemangiopericytoma
b. Infectious meningitis: Bacterial - Viral
c. Granulomatous meningitis: TB - Sarcoidosis - Wegner granulomatosis - LCH
d. Meningeal carcinomatosis

B. Neurovascular structures In foramina:

a. Nerve sheath tumors: Schwannoma – Neurofibroma
b. Malignant nerve sheath tumor
c. Paraganglioma

C. Skull base:

a. Osteosarcoma – Ewing sarcoma – Hemangioma
b. Chordoma – Chondrosarcoma
c. Leukemia – Lymphoma – LCH
d. Metastasis – Multiple myeloma (Plasmacytoma)
e. Fibrous dysplasia – Paget disease

D. Supra-cranial lesions with caudal extension:

a. Suprasellar lesions: Pituitary macroadenoma
b. Petrous/CPA/IAC lesions

E. Sub-cranial lesions with cranial extension:

a. Sino-nasal tumors
b. Orbital tumors
c. Nasopharyngeal tumors
d. Parotid tumors
e. Masticator space tumors
f. Carotid space tumors

DD by Location:

A. Anterior cranial Fossa:

a. Central
    i. Midline sino-nasal congenital anomalies
    ii. Sino-nasal tumors
b. Lateral
    i. Orbital tumors

B. Middle cranial Fossa:

a. Central:
    i. Sellar / suprasellar / parasellar tumors
    ii. Nasopharyngeal tumors
b. Lateral:
    i. Parotid tumors
    ii. Carotid space tumors
    iii. Masticator space tumors

C. Posterior cranial Fossa:

a. Central:
    i. Clival Tumors
    ii. Foramen magnum Tumors
b. Lateral:
    i. Petrous
    ii. CPA / IAC tumors
    iii. Jugular foramen tumors